ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXIX. No. 12.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 265

English Saloon Cars..... 266
Concrete Highway Bridge in Germany (*illustrated*). 266
World's Columbian Exposition—V. (*illustrated*)..... 267
Landslides on the Bolan Railway, India..... 268
The Engle System of Garbage Cremation..... 268
The Dredge-Steward-Omni Telemeter (*illustrated*) . 269
Cost of Electric Lighting at Topeka, Kan..... 270
Utilization of Water Power in Southern India..... 270
Carborundum, a New Abrasive Material..... 271
The Gray Telautograph (*illustrated*)..... 271
Zone System of Railway Fares in Ireland..... 272
The Utilization of Water Power at the Minnehaha Falls..... 273
Notes from the Engineering Schools..... 281
Freezing Test for Building Stone..... 281
The Steamship "Fuerst-Bismarck," Hamburg-American Line (*with inset*)..... 282
Matter Held in Suspension in Moving Water..... 283
Railway Convention in India..... 283

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS..... 273, 275

EDITORIAL NOTES..... 276

New System of Thermal Storage—Measurement of Masonry—Carborundum.

EDITORIALS:

Rapid Transit for Boston..... 276
What Is to Become of Our Timber Supply?..... 277
American and English Railway Cars..... 278

LETTERS TO THE EDITOR..... 279

Automatic vs. Manual Block Signals—English and American Locomotives—The Effect of Tapping for Turpentine on Long-Leaf Pine Timber—Minneapolis Water-Power—Cotton Bagging for Temporary Levee Protection—Notes and Queries.

CONSTRUCTION NEWS..... 284, 286

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous.

INDUSTRIAL NOTES..... 286

INDUSTRIAL SUPPLEMENT..... 287, 292

A two-cylinder compound engine of the eight-wheel type has been built at the Altoona shops of the Pennsylvania R. R. The cylinders are 19½ × 24 ins. and 31 × 24 ins. The four driving wheels are 7 ft. diameter, carrying 40 tons, and the four-wheel truck, with 42-in. wheels, carries 25 tons. The engine weighs 145,000 lbs. and tender 69,440 lbs. The boiler is 5 ft. diameter, with firebox 9 ft. long and 3 ft. 4 ins. wide. The boiler is 6 ft. 6 ins. clear from the rails, and the working pressure is 200 lbs. per sq. in.

Nine powerful engines of the mastodon or twelve-wheel type have been built for the ore traffic on the Duluth & Iron Range R. R. by the Schenectady Locomotive Works, Schenectady, N. Y. They have cylinders 22 × 22 ins.; eight driving wheels 4 ft. 6 ins. diameter, and a four-wheel truck. Boiler pressure, 180 lbs. The tender tank has a capacity of 3,500 gallons, and the engine and tender together weigh 240,000 lbs. They were designed by Mr. Pitkin, Superintendent of the works, and are somewhat similar to the engines built for the Iron Range & Huron Bay Ry. by the Brooks Locomotive Works, Dunkirk, N. Y., and illustrated and described in our issue of June 16, 1892.

A large timber dry-dock is to be built at Algiers, La., opposite New Orleans, for the use of the Navy Department. As proposed the dock will be as large as the last one commenced at the Brooklyn Yard, and it will accommodate warships of the Gulf and South Atlantic fleets in one of the best protected naval stations on our coast.

The Wisconsin Water Co. has been attempting for some time to build a pipe-line from Waukesha, Wis., to Chicago, for the purpose of piping that famous water to the city named, in time for the Exposition. Local opposition has been met with which, if successful, would have practically prevented the company from leaving the village. A decision of the Supreme Court now materially aids the company in its endeavor, in refusing to grant a 60-day stay of proceedings, and the submission of the case to the Illinois legislature. As Waukesha is about 25 miles west of Milwaukee, the length of the pipe-line to Chicago would be about 100 miles. Further information regarding this project, the legal difficulties involved, the character of the pipe-line, and the proposed methods of distribution at Chicago was given in our issues of March 19, 1892, and Jan. 12, 1893.

A tunnel has been commenced in Chicago, under the Chicago & Northwestern R. R. track, on Kinzie St., which will connect Sacramento Ave. and Central Park Boulevard. It is being built by the Griffin Wheel & Foundry Co., whose works adjoin the tracks, and whose transportation facilities will be much increased by the tunnel. The total length of the improvement will be 500 ft., but only 100 ft. is covered. The tracks will be carried upon steel beams covered with concrete. The roadway will be 20 ft. wide, with 12 ft. headway, and will be paved with cedar blocks. The tunnel will be lighted by electricity. The total cost is estimated at about $60,000, and the plans have been made by Mr. W. L. Stebbings, of Chicago. Mr. W. Reilly is the engineer in charge and the contractors are Wilson & Jackson, of Chicago.

An electric boat, larger than any heretofore built, is under construction at Tacoma, Wash., for the Point Defiance Street Railway Co. The vessel will be 56 ft. long, with 10 ft. beam and 4 ft. depth. Current will be furnished by 75 storage battery cells, each 15 × 14 × 14 ins. These cells will be so placed as to act as ballast. The cells will be charged during the night from the street railway circuit, and the boat will be run in connection with the lines of cars during the day. If the vessel is successful, it is intended to build several others of the same type, to run on Puget Sound, in the vicinity of Tacoma.

Railway girder bridges in India are to be examined to ascertain their strength and condition. According to "Indian Engineering," the government of India proposes to issue a set of rules to regulate working strains on railway bridges, and has already called the attention of all government inspectors of railways to the strength of existing iron and steel girders of railway bridges. Many girders have now been in use for 25 years or more, and, owing to successive increases in the axle loads of engines and rolling stock, are, it is thought, subjected to heavier strains than they were originally designed to bear. Government inspectors are therefore asked to arrange for an early and thorough investigation of all girder bridges on railways, in order to ascertain whether they are of sufficient strength for the loads they are at present required to carry; and they are also required to specially note on the subject in their periodical inspection reports. The rules which it is proposed to issue are for the guidance of inspectors in determining the stability of iron or steel bridges.

The coming naval review will doubtless be the most remarkable naval exhibit this country has ever seen—at least in the character of the ships taking part therein. The United States will be represented by 15 ships of the "new navy," with the "Baltimore," 4,600 tons, as Admiral Gherardi's flagship; England is to send eight ships under Vice-Admiral Sir J. D. Hopkins, who will have the "Blake," of 9,000 tons, for his flagship; Russia will have six ships, under Vice-Admiral Kornakoff, in the "Dimitri Douskoi," of 5,796 tons; Italy sends three ships, under Rear-Admiral Maguaghi, in the "Etna," of 3,530 tons, and Spain sends three ships. France has not yet designated the four warships to represent her; Germany will send two ships, and Brazil, Portugal, Netherlands, Chili and Japan will all be represented. So far a fleet of nearly 50 modern warships is expected to rendezvous at Hampton Roads on April 17, and to sail thence to New York on April 24, and be in position in New York Harbor in time for the review of April 26.

The corner of a store and flat building being erected at State and 65th Sts., Chicago, Ill., collapsed March 11. The building is a four-story structure, 80 × 100 ft., with stone front, and was being completed when the entire corner, about 25 ft. square, collapsed, carrying three men down in the wreck. According to the press dispatches, the accident is attributed to the defective foundation under the corner pillars. This was a separate piece of masonry supporting two iron columns on which rested the entire portion that collapsed. The contracting mason was Thomas Johnson, who affirmed that his work had been done in strict conformity with the specifications of the architect, Francis J. Morton, and said the collapse was due either to frost having weakened the stonework, or to some defect in the plans. Building Inspector Westberger said he had been looking out for the work on the building and thought the contractors had done their work well. The insecurity of the foundation under the pillars was the cause of the accident, he was certain, but he was uncertain whether the architect or Mr. Johnson was to blame.

The official report upon the pneumatic guns of the "Vesuvius" is favorable. The board of officers decides that while the accuracy of the guns still leaves something to be desired, it is still reasonably sufficient for the purposes of naval warfare in comparatively smooth water. The fact is established that a heavy charge of a high explosive can be safely discharged from the guns; and that they are reliable with a fulminate fuse, though the fuse experimented with at Port Royal was defective. The board also believes that the system is capable of mechanical improvement, and suggests such improvements in their report. The "Vesuvius" will now probably be equipped with service projectiles, and retain her present armament of pneumatic guns.

A great telescope for the new government observatory on Georgetown Heights, D. C., has been finished by Warner & Swasey, of Cleveland, O. The tube is 32 ft. long and 3 ft. in diameter at the middle, and the total weight is 30 tons.

The office of the Metropolitan Sewerage Commission of Massachusetts was destroyed in the late Boston fire, and plans and records representing about $50,000 were burned.

The question of forest preservation is likely to be taken up by the Mexican government, the dry seasons during the past three years having aroused interest in the question. The rainfall is said to have been greatly lessened by reason of the wholesale destruction of forests. It is probable that the forestry systems of France and Germany will be imitated. One of the ancient kings of Texcoco, tributary to Montezuma, decreed a law compelling the planting of five trees for every one cut down in his dominions, but when the conquest came the Spaniards proved to be "ruthless foes" to the forests, and the tablelands of Mexico are largely denuded of trees.

The International Tramways Union, of Europe, has announced that the session which was to have been held at Buda-Pesth last September, but was deferred on account of the presence of cholera, will meet at Buda-Pesth early in September, 1893. The original programme will be adhered to. This organization is composed of representatives of street railways, and is similar to the International Railway Congress, noted in our issue of March 26, 1892.

Heliograph signaling is largely employed in India for military purposes, and on the East Coast Ry. telegraphic communication is maintained across the Godavari River by a pair of ordinary heliographs as used in military service. The distance is two miles, and, so long as the sun shines, the work is quite satisfactory; slower than the usual wire signaling, perhaps half the speed, but good enough for all practical purposes. In cloudy weather or by night the signaling can be carried on by the aid of an ordinary lantern at each instrument. The operators are ordinary telegraph men. The heliographs are scarcely more bulky than prismatic compasses.

The project of Mr. Zipernowsky for an electric railway between Vienna and Buda-Pesth can be (a London correspondent writes us) consigned to oblivion. It is said to be open to doubt whether the scheme was advanced as a serious undertaking. It provided for the running of single cars at very high rates of speeds, the current to be generated at power stations along the line.

The French-Canadians of Roman Catholic religion in the six New England states are said to number 302,659, out of a total of 1,151,000. The greater number are in the three northern states, as follows:

	F.-C.	Total.
Maine	40,919	71,000
New Hampshire	40,302	70,000
Vermont	33,204	45,000

In a recent book on "The French-Canadians of New England," by Rev. E. Hamon, this extraordinary emigration is referred to, and he thinks that the emigrants should not assimilate with the American people, even when living among them, but should retain their language, customs and religion as a distinct people.

The city of Florence offers to any properly constituted syndicate or company financially responsible, the right to supply that city with water for 60 years. The estimated cost of building the works lately planned is about $5,000,000. The water-rates now produce an annual profit of $600,000 to the city; but the present quantity is insufficient. With an abundant supply they estimate that this income could be quadrupled. All present wells in the city would be closed by law. The proposed source of supply is a group of springs in the Garfagnana region, beyond the baths of Lucca. The aqueduct would start from Pollaccia, 1,804 ft. above the sea, and taking in other springs would pass through several tunnels, and over several rivers by double siphons, to Florence, ending at an elevation of 715 ft. above sea level. A reservoir of 40,000 cu. m. capacity would be built near Florence. The total length of the line of supply aqueduct would be 338,644 ft., or about 64 miles. It would skirt the edges of mountains above Pescia, Pistoia, Prato and Sesto, to S. Silvestro, above Florence.

The Northern Railway of the South African Republic (Transvaal), is building a line between Komati-Nelspruit and the district of Selati, under a concession granted to a Franco-Belgian syndicate, whose offices are in Paris. The line, as surveyed, is 192½ miles long, and 25 miles are expected to be completed this spring. An issue of bonds for $2,500,000 has recently been advertised in London.

ENGLISH SALOON CARS.

The London & Southwestern Ry., of England, is building at its shops several special saloon cars for the steamboat express, to run between London and Southampton, 79 miles, in connection with the American Line of steamers between Southampton and New York. English papers claim for these cars the "safety of Pullman car construction," which is apparently incorrect, as there are said to be side doors, interrupting the continuous truss system, which gives the great longitudinal strength to the American cars. An ordinary compartment is provided for those exclusive individuals who find more privacy in being shut up in an English compartment, face to face with strangers, or perhaps with unpleasant or objectionable fellow passengers, than in the saloon, where passengers are seated separately, instead of side by side and face to face. According to the published descriptions, each saloon car will be 47 ft. 6 ins. long,, over all, and will accommodate 25 persons, though a saving of dead load might have been effected by longer cars of greater capacity. The width is 8 ft., and the length is divided as follows:

	Ft.	Ins.
Saloon	20	1
Women's room (boudoir)	6	10
Women's retiring room	2	6
Smoking room	6	10
Men's lavatory	3	6
Private compartment	6	10
Total	46	7

The main saloon is open throughout, and has twelve seats, six on each side. At one end is the smoking room, and at the other end the women's room. The private compartment has no communication with the rest of the car, and its few exclusive occupants have the privilege of a special lavatory for their use during the trip. The cars are slightly higher than the ordinary cars, but the limits of the English loading gage preclude the possibility of adopting the width and height of American cars, as noted in our issue of Oct. 10, 1891. The head-lining is of lincrusta, a papier-mache preparation. The sides are finished in Hungarian ash with walnut moldings, and the upholstering and carpeting are of a more elaborate character than is usual in English cars.

The frame is of timber, trussed by 1⅛-in. rods. Rubber pads are placed between the body and frame to deaden vibration. The cars are carried on four-wheel trucks, with 43-in. wheels and a wheel base of 8 ft. The truck frames are of the Fox pressed steel pattern. The trucks have helical springs at the sides, and transverse elliptical springs. The car buffers have spiral springs, and the drawbars have india-rubber springs. The cars are equipped with the Vacuum Brake Co.'s automatic brake, with two brake cylinders, one to operate the brakes of each truck.

A commendable feature in the construction of these cars is the attention paid to ventilation, which is arranged for by mechanical (Laycock's torpedo) ventilators, and in our issue of Aug. 25, 1892, we called attention to the necessity of a more efficient system of ventilation for American cars. The cars will be lighted by the Pintsch compressed oil gas, stored in two iron reservoirs, with three double-burner lamps in the saloon, and a double-burner lamp in each of the other divisions. The reservoirs carry sufficient gas for 48 hours. No provision is made for heating, so that in winter the passengers must encumber themselves with rugs and endeavor to be satisfied with the ridiculous and inefficient hot water "foot-warmers," the supply of which is never sufficient, so that porters receive numerous tips from experienced travelers who want to make sure of such comfort as may be obtained from this device. The trains will be hauled by the handsome eight-wheel outside cylinder engines, with 7-ft. driving wheels, illustrated in our issue of April 18, 1891.

At the same works refrigerator cars are being built for the meat traffic, and 50 meat wagons are also being built to convey the meat from the ship's side to the London and other markets. These wagons will be so constructed as to be carried on flat cars, in the same way as furniture wagons are carried. At Southampton they will be lifted off the cars by means of cranes or otherwise, and taken to the ship's side. The meat will be loaded, and the vans will again be placed on the cars and taken to London, where horses will be attached to them, and they will be taken direct to the market to be unloaded. All unnecessary handling of the meat will thus be avoided, which is an important consideration. The vans are fitted with hooks and bars, so that the carcases will be suspended from the roofs. Special arrangements are made for ventilation.

The London & Southwestern Ry. and its equipment were described in our issues of Oct. 18, May 16 and June 13, 1891. The road had then two Pullman drawing room cars, and is now adding two more vestibuled Pullman cars to its equipment, each 52 ft. long., upholstered in old gold plush. The cars were built in this country and sent to England in sections, to be put together at the railway company's car shops. A saloon car for the Furness Ry. was described in our issue of Oct. 3, 1891. In our issue of Oct. 10, 1891, we described and illustrated some American cars built for the Southeastern Ry., and in our issue of April 28, 1892, we described and illustrated the corridor cars of the Great Western Ry., while English and American cars have been compared in various issues, including July 4, 1891, and Sept. 26, 1891.

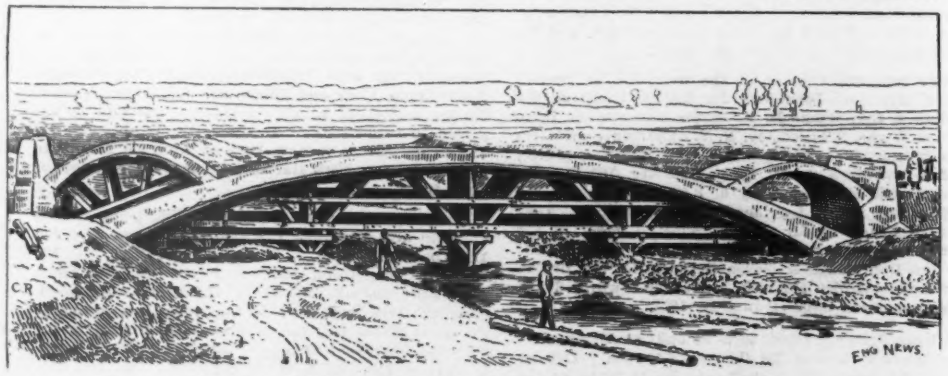
The London & Northwestern Ry. has sent over for exhibit at the World's Columbian Exposition a combined sleeping and parlor car (or sleeping saloon and day saloon car) and an ordinary standard compartment car, as noted in another column, and these cars will be objects of considerable interest to American railway men and the general public. The cars have side entrances, the saloon car having two doors on each side, and the ordinary car two doors to each compartment. The saloon car has a shallow monitor roof, and a narrow vestibule for connection with similar cars when coupled together, but this vestibule connection is not intended for general use. The cars are carried on four-wheel trucks, with steel tired wheels, having teak centers. The trucks are found to be more satisfactory than the radial axle arrangement used on some of the cars of this road. The first dining cars on this road had the latter arrangement, but the new dining cars built at the company's car works at Wolverton in 1890 (Eng. News, April 11, 1891) were fitted with trucks, or "bogies," for the reason, as we were informed at the time, that they were found to give better results in service.

The saloon car is used as a sleeping car by night and a parlor car by day, in the same way as our Pullman and Wagner sleeping cars, but the interior arrangement is different from that of the ordinary American sleeping car, being equipped with staterooms instead of the curtained berths, an arrangement carried out, however in the American compartment sleeping cars, as illustrated in our issue of June 16, 1892. Attached to the staterooms, which are of sizes to suit two or more persons, are lavatories. All the staterooms together accommodate 14 passengers. They are entered from a corridor on one side only, instead of in the middle of the car, so that there is ample room for dressing This arrangement is made necessary by the limited width of English cars, as already referred. As a day saloon the English car also differs somewhat from the American parlor car in having more private apartments for those who wish to repose upon sofas during a journey, by day as well as by night. The ordinary compartment car is known as a composite car, divided into compartments for first, second and third class passengers, and capable of carrying 32 persons. These cars are only 42 ft. long and weigh but 51,520 lbs. The cars are painted in the uniform style of the London & Northwestern Ry., a chocolate color up to the sills of the windows, and above that white. The lettering is of gold and the general effect is very handsome. The equipment of the London & Northwestern Ry., including the style of saloon cars used on its special steamboat expresses between Liverpool and London, was described and illustrated in our issues of June 21, 1890, and April 11, 1891.

Changes are made very slowly in England, but the railway men and the public are being educated to the understanding that there are better, more convenient and more comfortable arrangements of passenger cars than those of the English compartment cars. That this is so is proved by the growing introduction of Pullman, dining room, corridor and saloon cars; and in another column we point out the fallacy of the arguments made for the so-called privacy of the English compartment system.

CONCRETE HIGHWAY BRIDGE IN GERMANY.

An interesting type of framed concrete arch built near Erbach, Wuertemberg, Germany, is described in the "Deutsche Bauzeitung." The span of the arch is 105 ft., with a rise of 13.1 ft. In order to prevent cracks in the structure, and to counteract any motion in the abutments, which were constructed in somewhat soft ground, thin asphalt plates were inserted into the arch, two at each end, near the springing lines, and one in the apex. A similar use of lead plates was described in our issue of Oct. 4, 1891. These asphalt plates had a thickness of ⅞ in. at the top, and 19-32 in. at the bottom and were made up of several layers. After the arch had settled 1.9 ins. these plates were compressed to a uniform thickness of ½ in. When the roadway ballast had been filled in, the total settling of the arch amounted to 4.7 ins. The thickness of the arch at the apex is 19.7 ins., and at the springing line 27.5 ins. The bases of the abutments are 11.5 ft. wide, and are 8.2 below low water mark. The strains upon the ends of the arch were partly taken up by smaller arches, as shown in the illustration. The greatest admissible compressive strains in the structure amount to 66.14 lbs. per sq. cm. The cement used showed a crushing strength of from 35.27 to 39.7 lbs. after seven days, and from 48.5 to 52.9 lbs. after 28 days. The concrete used for the abutments was



A CURIOUS EXAMPLE OF CONCRETE ARCH CONSTRUCTION.

made up of 1 part cement, 2 parts of sand, 6 parts of gravel and ½ part of limestone rock broken into pieces, weighing from 22 to 44 lbs. each. The concrete for the springers and lower parts of the haunches of the arch was composed of 1 part cement, 1.25 parts of sand and 3 parts of gravel. With the exception of the sand, of which only 1 part was used, the same proportions were retained for the part near the crown of the arch. The gravel used ranged between the sizes of a walnut and of an egg, and was carefully washed. The ramming of the concrete was done in layers 31.5 ins thick. The centering was left undisturbed for two months after the arch had been constructed.

The earth oil, or petroleum, wells in Burma which have been successfully worked for some years by Hannay & Co., have been acquired by a stock company, which has taken over the concession and will largely develop the output. In 1888 the output was about 2,450,000 gallons, and 2,800,000 gallons in 1890. The wells are said to have been worked in the ancient times.

WORLD'S COLUMBIAN EXPOSITION.—V.
Sewerage and Sewage Disposal.

As already stated, there will be a very complete system of sewerage, and the Shone hydro-pneumatic system has been adopted for collecting the sewage and forcing it to the disposal works. The Shone system was described in our issue of Aug. 4, 1892, and we give in Fig. 1 a section of one of the ordinary ejectors. The sewage flows by gravity from the sewers through the inlet pipe A into the ejector chamber and gradually rises therein, until it reaches the underside of the bell D. The air at atmospheric pressure inside this bell is then inclosed, and the sewage continuing to rise around it its buoyancy is sufficient to lift it with the spindle, etc., and to open the compressed air admission valve E. The compressed air thus automatically admitted into the ejector presses on the surface of the sewage, driving the whole of the contents before it through the bell-mouthed opening at the bottom, and through the outlet pipe B, into the iron sewage discharge pipe, or in some cases into a high-level gravitation sewer. The sewage can only escape from the ejector by the outlet pipe, as the instant the air pressure is admitted upon the surface of the sewage the valve on the inlet pipe A falls on its seat and prevents the fluid escaping in that direction.

The sewage passes out of the ejector until its level falls to such a point that the weight of the sewage retained in the cup C, which is no longer supported, is sufficient to pull down the bell and spindle, thereby reversing the compressed air admission valve, which first cuts off the supply of compressed air to the ejector, and then allows the air within the ejector to exhaust down to atmospheric pressure. The outlet valve then falls on its seat, retaining the liquid in the sewage discharge main; and the sewage flows through the inlet once more, and so the action goes on as long as there is sewage to flow. The position of the cup and bell is so adjusted that the compressed air is not admitted to the ejector until it is full of sewage, and the air is not allowed to exhaust until the ejector is emptied down to the discharge level; thus the ejector discharges a specific quantity each time it operates.

The application of this system to the World's Columbian Exposition was described in a paper on "The Shone Hydro-Pneumatic System of Sewerage," by Mr. U. H. Broughton, engineer for this

Sewage Ejector, Shone Hydro-Pneumatic Sewerage System.

system, read before the American Society of Civil Engineers (Eng. News, Dec. 29, 1892), and published in the December, 1892, number of the Transactions, from which paper we abstract the following particulars respecting the Exposition sewerage and sewage disposal plant.

The largest installation of the Shone system in this country is at the World's Columbian Exposition, the site containing rather more than 600 acres. The buildings provided for the purposes of the Exhibition are 16 in number, and vary in size from 1 to 32 acres each; in addition there are 40 or more buildings of smaller size, built by individual state and foreign governments, which bring the total roof area up to about 150 acres. A daily attendance of 150,000, with a possible maximum of 400,000, is anticipated. For the accommodation and convenience of this multitude there will be provided in the Exposition buildings 25 or 30 cafes or restaurants, of an average area of 5,000 to 6,000 sq. ft. each, with public and private dining-rooms. There are also in these buildings toilet rooms and lavatories, containing a total of 3,000 water-closets and urinals, and wash-basins in proportion. In addition there are toilet rooms with water-closets, etc., in the 40 or more buildings of the states and governments. As the site is very flat, varying from 5 to 11 ft. above Lake Michigan, any system of collection of sewage by gravitation sewers alone would necessitate very light grades; it was therefore decided to put in a separate system of sewers for the removal of the sewage proper, and to pump the sewage to purification works situated in the southeast corner of the grounds. Mr. W. S. MacHarg, Chief Engineer of Water Supply, Sewerage and Fire Protection, having had practical experience of the working of the Shone system in Chicago, recommended its employment for the removal of the sewage of the entire area.

Over the area of the grounds 26 ejector stations are located; the majority of them underneath the floors of the buildings, some underneath grass swards, and others underneath roadways. In each station two ejectors are placed, varying in capacity from 60 to 600 gallons each per minute, and having a united discharging capacity of 17,000,000 gallons per 24 hours. This is a larger plant than would be required for the removal of the sewage of any city in the United States, with probably ten exceptions. Converging to these ejector stations are three miles of gravitation main sewers, the minimum grade adopted being 1 in 250. The vitrified sewer pipes are laid in 2½-ft. lengths, and have extra deep sockets in order that water-tight joints may be insured; inside the buildings the sewers are of cast iron.

The air-compressing plant for operating the ejectors was designed and built, and is placed as an exhibit in the Machinery Hall, by the Norwalk Iron Works Co., of South Norwalk, Conn. It consists of three compound air-compressors, and one double compound air-compressor, the principal dimensions of which are as follows:

	Air cyl. ins.	Stroke ins.	Diam. steam cyl. ins.	Diam. compress. cyl. ins.
One compound compressor.....	26	30	24	17½
Two compound compressors...	22	24	20	13½
One double compound comp....	18	16	h.p. 10 / l. p. 16	9½

The distinctive features of these air-compressors are, that they have two air cylinders with cooling chamber between. A large air cylinder is employed to make the initial, and a small cylinder the final, compression. By such an arrangement a more nearly uniform resistance for the whole stroke is obtained. The air is admitted to the large cylinder by valves of the Corliss steam-engine pattern, which have positive movement from the main shaft. The air is partially compressed in the large cylinder, and forced thence into the small one through a chamber filled with copper pipes, through which cold water circulates. In the small cylinder the air is compressed to the extent desired. Both inlet and outlet valves can be taken out without removing a cylinder head. The piston rings can also be taken out without removing the piston from the cylinder. Both air cylinders are surrounded by water jackets. The steam and air pistons and cross-head are mounted on the same piston rod, so as to render the application of power uniform. Two fly-wheels are used, one on each side of the machines, and, by means of a swivel in the center of the cross-head, the work is made exactly equal upon both connecting rods. The steam cut-off is changed by turning a hand wheel at the back end of the valve chest.

The plant has a capacity of 4,537 cu. ft. of free air per minute. Leading from the central plant is a system of air pipes, 5 miles in length, varying in diameter from 2 ins. to 10 ins. The air pipe outside the buildings is ordinary cast-iron water-pipe laid with lead joints. This pipe line was tested to withstand 90 lbs. Inside the buildings it is of wrought iron with screw joints. The pipe line was tested to withstand 90 lbs. per sq. in., without appreciable loss. From the ejectors to the purification works is a system of cast iron sewage discharge pipes, 4.8 miles in length, varying in diameter from 6 to 30 ins. The maximum direct lift from the discharging level of the lowest ejectors to the top of the sewage receiving tanks is 67.62 ft.; and the total head to be pumped against, when the maximum estimated amount of sewage is being discharged, is 107.87 ft. The air in the air mains will be maintained at a pressure of 47 lbs. per sq. in., and supplied to each ejector station through reducing valves at the exact pressure required at each station.

The sewage receiving tanks, four in number, are constructed of steel plates riveted together. Each tank is 32 ft. in diameter and 55 ft. high, the bottom, 22 ft., being in the form of a cone. This design of tank was first used at Dortmund, Germany, by Carl Kinebuhler. After the sewage has received its precipitating agent, it flows through a large tube fixed vertically in the center of the tank to a depth of about 30 ft., where, by means of radial arms, it is distributed over the area of the tank and slowly rises to the top. The heavier matter settles gradually to the bottom of the tank as sludge, and in the process of doing so acts as a filter for the rising sewage. It is claimed that by means of this mechanical operation the chemicals are utilized to their full advantage. The effluent water overflows at the top of the tank, and will be conveyed to Lake Michigan, while the sludge will be pressed into cakes and burnt. This form of tank takes up very little space. The tanks, mixing vats, engines, boilers and sludge presses are contained in a building 100×125 ft. For economical reasons it was deemed advisable to build the tanks above the surface of the ground. The works are nearly completed, and a section of them was put into operation during the dedication ceremonies, in October, 1892, for the convenience of an attendance estimated at 200,000.

Garbage Cremation.

All garbage, waste and refuse collected inside the grounds will be disposed of by two cremating furnaces put in by the Engle Sanitary & Cremation Co., of Des Moines, Ia,. and New York, N. Y., whose system is described in another column. These furnaces are located at the extreme southeastern portion of the inclosure, near the lake, and in the vicinity of the Forestry Building, the Anthropological Building and the stock exhibit barns, and adjoining the sewage disposal plant. These furnaces are placed back to back, and together are 50 ft. long, 18 ft. wide and 15 ft. high. They each have a daily capacity of 50 tons of household swill or 150 cu. yds. of miscellaneous combustible waste. All the refuse from restaurants, hotels and buildings within the inclosure, the sludge from the sewage purification plant, amounting to from 12 to 15 tons per day, the large quantity of refuse packing material, and also the manure from the stock yards, will be destroyed in these furnaces.

The furnaces are surrounded by wide platforms which allow the carts to discharge their loads directly into the four openings in each furnace. The heat is obtained from fuel oil, as used also in the steam boiler power plant, the oil being applied in the same way that the coal fires are used in other furnaces, as described elsewhere, except that at the base of the stack an extra combustion chamber, 7 ft. long and 9 ft. wide, is constructed, which is heated by an additional oil burner, and communicates directly with the base of the stack. The compressed air for spraying this oil is obtained from the power plant which supplies the Shone hydro-pneumatic sewerage system, above described, with a pressure of 100 lbs. per square inch. The covering house, which is 37 ft. long, 35 ft. wide and 35 ft. high, is constructed in the usual way, of the cement plaster material called "staff," so largely used in the Exposition buildings, and has an ornamented exterior to correspond with the other buildings within the grounds.

The chimney is 50 ft. high and 9 ft. square at the base, and supplies both furnaces. A new form of hydro-carbon burner has been adopted, which is said to have been proved by exacting tests to be the best adapted for this work that has ever been used. The furnaces are expected to be put in operation about April 1, when the garbage collection system of the Exposition will be brought into use. The collection of garbage will be performed by the Exposition authorities, using an improved form of cart with a close cover, which was devised for this special purpose. The adoption of the Engle system was made after a thorough examination of all the methods in use, and the company constructed the cremators as an exhibit—the only operative exhibit of its class allowed within the boundaries of the Exposition. The building is provided with galleries to enable visitors to inspect the work. The whole work of the sewage collection by the Shone system and the sewage purification, and the garbage collection and its disposal by cremation, will form together an exhibit of the utmost interest and value for sanitary purposes.

English Railway Exhibit.

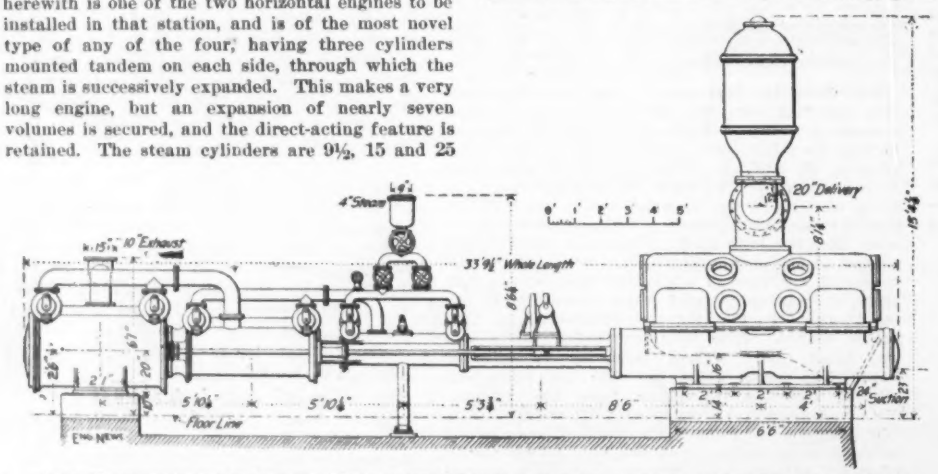
The London & Northwestern Ry. has sent over a locomotive and two cars of the most modern style of English construction, and these arrived recently on the White Star steamer "Runic." The locomotive, named the "Queen-Empress," is an express engine of the three-cylinder, compound system, invented by Mr. F. W. Webb, Locomotive Superintendent of the L. & N. W. Ry. (Eng. News, Jan. 26, 1889; Feb. 16, 1892), and one of

which has been in service on the Pennsylvania R. R. for some years with satisfactory results. The engine has four driving wheels, 7 ft. 6 ins. diameter, and a single pair of leading and trailing wheels. The engine weighs 47 tons, while the six-wheel tender weighs 13 tons; the total weight of engine and tender in running order being 80 tons. The cars are a sleeping and day saloon car and an ordinary compartment car, each 42 ft. long and weighing 23 tons, and are referred to in another column, with other English cars. The train was consigned to Mr. C. A. Barratoni, of New York, General Agent in this country for the London & Northwestern Ry. Under his supervision and that of Mr. George R. Chesworth, a foreman of the railway company's locomotive works at Crewe, the locomotive and cars were hoisted from the steamship by a huge floating crane borrowed from the Brooklyn Navy Yard and placed upon floats to be towed to the railway yard at Sixtieth St., North River. They were put in the middle of a freight train and hauled to Chicago over the New York Central R. R. and Lake Shore & Michigan Southern Ry.

Along with the train several other exhibits of the English railway company will be sent to Chicago. The most important of these is a reproduction of the "Rocket," built by George Stephenson, and first operated on the Liverpool & Manchester Ry. (now a part of the L. & N. W. Ry. system), in 1829. Another is a model of one of the L. & N. W. Ry. engines, named the "Dreadnaught." The cost of the company's exhibit is about $50,000, and it will occupy about 2,800 sq. ft.

The Worthington Six-Cylinder, Triple-Expansion Pumping Engine.

We described last week the Worthington pumping plant, and illustrated the two large vertical pumping engines which are soon to be installed in the Worthington pumping station. The engine shown herewith is one of the two horizontal engines to be installed in that station, and is of the most novel type of any of the four, having three cylinders mounted tandem on each side, through which the steam is successively expanded. This makes a very long engine, but an expansion of nearly seven volumes is secured, and the direct-acting feature is retained. The steam cylinders are 9½, 15 and 25



WORTHINGTON SIX-CYLINDER TRIPLE-EXPANSION PUMPING ENGINE; WORLD'S COLUMBIAN EXPOSITION.

ins. diameter, and water cylinders 11 ins. diameter, all of 48 ins. stroke, and the daily pumping capacity is 5,000,000 gallons. The engine was described more fully last week. A duplicate of this engine has just been furnished for the water-works of Brooklyn, N. Y.

The government mechanical testing station at Berlin-Charlottenburg, under the direction of Professor Martens, attended to 790 orders for testing from April 1, 1891, to April 1, 1892 (the German fiscal year). According to the "Deutsche Bauzeitung" 251 of these referred to the testing of metals, necessitating 2,449 single tests; 422 requests were made for the testing of papers and fabrics, and 98 for the testing of oils. The efficiency of several testing machines had to be demonstrated by 19 tests. In the scientific department, hammer tests, microscopic examinations of polished metals and tensile tests of steel chains without welded seams, were conducted. The testing station for building materials under the direction of Prof. Dr. Boehme absolved during the term mentioned 1,004 orders, involving 19,750 single tests; of this number 888 requests, necessitating 8,644 tests in reference to the qualities of natural and artificial stone, and 116 orders, involving 11,106 separate tests on the properties of different mortars and cements, were attended to. A great number of the tests were conducted purely in the interest of science.

LANDSLIDES ON THE BOLAN RAILWAY, INDIA.

Serious landslips have occurred on the railway to Quetta, India, at a place where an entire mountain seems to have been disturbed by the construction of the railway, with somewhat the results, apparently, as in the great Culebra cut in the Panama Canal, where the whole mountain is said to move gradually into the cut. The "Indian Engineer" says that the committee of engineers appointed to examine Mud Gorge, on the Hurnai route to Quetta, will have a task of unusual difficulty in deciding how best to locate the railway so as to insure its permanence. The recent landslip was not due apparently to excessive local rainfall. A mass of the hill came down rather quietly, but did a large amount of mischief. Previous landslips have occurred, and it is a whole mountain that has to be dealt with, hence the trouble of securing the line against destruction on this particular section.

The two miles in and about Mud Gorge are a cause of more anxiety to the engineering staff than all the rest of the railway, for in spite of all the expedients adopted and the expenditure of vast sums of money, the mountain more than holds its own. The last plan adopted was to lay the rails some distance from the treacherous hillside, the idea being that when a landslip occurred the debris would simply cover up the track, and that it could be removed easily enough by the strong working gangs. But experience has shown how fallacious was this view. The hill slipped in such a way as to lift the track bodily up and turn it over, ties uppermost. The scene was a curious one after this occurrence, and might well make even the most determined trackmen despair, so complete was the wreckage and so strangely was the material bent and distorted. The worst feature, perhaps, is that the slope of the hill is gradual, and that the movement downward, when it does take place, partakes more of the nature of sliding than slipping. With precipitous cliffs it is always possible to cut portions away, get a natural slope, and thus guard against accidents. At Mud Gorge, with its dependency known as Puddle Hollow, no such safeguards are possible. The mountain is a great porous mass of clayey soil with large bowlders imbedded therein, and it sucks in moisture like a sponge. After heavy rain it begins to move downward, and even in dry weather disintegration goes on with disastrous results to the railway. It is now reported that new fissures have appeared hundreds of yards up the slopes above the line, and each of these indicates that thousands of tons of earth and bowlders will sooner or later find a lower level. The committee of experts appointed by government will thoroughly examine the mountain, and if they succeed in devising means to conquer it, they will achieve a notable feat in engineering.

The railway alluded to is the Bolan Railway (Eng. News, Nov. 1, 1890), now a part of the Northwestern Railway system, extending northeastward from the Afghan border, crossing the Bolan Pass to Quetta, and having Kandahar as its objective point, mainly for military and strategic purposes. As the difficulties in construction are found to be more serious than were contemplated, it is now stated that it will be necessary to construct a tunnel at Pamirbund, which would be as long as the Khojak tunnel (Eng. News, June 28, 1890; Oct. 10, 1890), which is further along on the same line, and is 12,600 ft. long, 23 ft. high by 32 ft. wide, for a double-track railway. This tunnel took several years to complete. As there have been further landslips on the Hurnai line, British railway communications with Quetta are causing considerable anxiety, and some military authorities consider that it would be best to construct a railway from Kurrachee to the Pisheen Valley, by way of Khelat and west of the Tahiri Range.

THE ENGLE SYSTEM OF GARBAGE CREMATION.

The method of disposing of city garbage and refuse by cremation is one which, if properly carried out, has many advantages from a sanitary point of view, and this method is in successful operation in some cities in this country. The Engle Sanitary & Cremation Co., of Des Moines, Ia., has now 32 of its furnaces, or cremators, in operation in 24 places, including Jacksonville, Fla.; Birmingham, Ala.; Findlay, O.; Savannah, Ga.; Butte City, Mont.; the McPherson Barracks at Atlanta, Ga.; Lowell, Mass.; and at Panama and other places. It has also put in a plant to destroy the garbage and refuse of the World's Columbian Exposition, as described in another column.

The Engle cremator is a rectangular brick structure, with openings in the top through which to feed the material. It has a fire at each end, with the garbage grate between them, so that the smoke and products of combustion from the garbage are thoroughly consumed. Below the garbage grate is a hearth, or pan, which catches and retains all liquid matter, which is then evaporated by the heat of the furnace. When the furnace is charged, the fires are lighted and the flames from the fire next the smokestack end pass over and through the garbage driving the smoke and gases to the second fire, where they are consumed. The flame and gases then pass over the top of, and down at the side of, the second fire and then through a return flue, which acts as a combustion chamber, under the garbage grate, to the stack. Fire doors and ashpit doors are provided on the same side of the furnace, and also small doors for stirring the garbage. Part of the garbage grate may be made of tubes, in which water circulates, so that there is a supply of steam and hot water for cleaning and disinfecting the pails, barrels, carts, etc., and for keeping the platform clean. The walls are lined with specially made fireclay blocks, 12×9×8 ins., laid close and backed by a double brick wall. All openings are protected by fireclay blocks made to shape, and no ironwork is exposed to the flame, as in the later furnaces the garbage grate is also of firebrick. On the outside the structure is held firmly together by braces, thrust bars, buckstays and tie rods. The fire doors are carried in iron panels similar to boiler fronts. Carts can discharge their loads directly into the openings. The covering house incloses the cremator and receiving slopes, and this is ventilated into the chimney. The cost of operation ranges from 9 to 17 cts. per cubic yard, according to the materials, fuel, etc.

Two furnaces of the largest size were built at Savannah, Ga., a city with a population of about 53,000. These furnaces were accepted by the city in February, 1891, after tests had been made. Each furnace is capable of destroying about 100 cu. yds. of garbage (free from sand and ashes) in 12 hours, or nearly the same number of barrels of night soil, and each furnace is guaranteed to burn 80 cu. yds. of garbage and 80 barrels of night soil per day. The following are the particulars of a test of 16 days:

	Cu. yds. garbage.	Bbls. of night soil.	Cords of wood.	Hours.
	80	42	4	10
	109	55	5	14
	45	12	2.5	8
	80	84	4	10
	83 (1 cow)	36 (31 liquid)	4	9
	98	54 (48 ")	3	10
	82	43 (39 ")	2.5	10
	75	1	1	5
	80.5	72	4	10
	88.5	72 (53 ")	3	10
Averages.	82.1	47 (18.9 ")	3.3	9.6

The number of men employed was four for the first three days and six afterward. The latter is considered the proper number. By putting on a second or night gang, it is estimated that about 150 cu. yds. could be burned in 24 hours. The wood used for the first five days was of inferior quality.

The night soil contained large quantities of liquid, which at first was difficult to destroy, but after some alterations had been made, no trouble was found in disposing of 30 to 50 barrels per day entirely of urine, besides the solid matter. The daily collection is about 40 barrels of night soil and 100 to 125 yds. of garbage, all of which is disposed of. The garbage includes waste and refuse of all kinds, not only house offal, animal and vegetable matter, but straw, leaves, paper, clothing, tinware, etc. Dr. R. R. Harris, Chairman of the Committee on Health, in his letter announcing to the company the acceptance of the cremators of the city, stated that there was no offensive smell whatever. In 1892 the average amount burned daily was 48.15 loads, or 135 cu. yds., at a cost of 13 cts. per cubic yard. The operation of feeding is said to be so rapid, and the combustion of smoke and gases so complete, that there is no nuisance caused, and there have been no complaints, although in some places the crematories are near dwellings and in thickly settled districts. Dead animals are burned easily without special preparation or any interference with the regular work. In some cases the numer of animals has been nearly 30 per month.

The latest garbage cremating furnace built by the Engle company for municipal use is at Lowell, Mass. This furnace was finished in January last, and has since destroyed on an average of 10 to 12 tons per day of household offal, using coal for fuel. The capacity of the furnace is 30 tons of household offal per day, and in addition 40 cu. yds. of combustible refuse and bodies of animals. On account of the high price of coal ($6 per ton) and the relatively small amount of garbage to be destroyed during the winter months, the Engle company is now adding an oil burning apparatus to this cremator, by means of which the cost of cremation, it is estimated, will be reduced by at least one-half. This does not impair the efficiency of the furnace to burn coal, as the fire boxes are retained, and the hydro-carbon burners introduced immediately over them in such a way that either oil or coal, or both together, may be used for the consumption of garbage. The adaptation of the Engle cremator for the use of either fuel or both, if desired, is a somewhat novel feature, and will be found useful in localities where the price of fuel fluctuates.

THE DREDGE-STEWARD OMNI-TELEMETER.

The instrument here described was primarily intended for a range finder by its inventors, Messrs. J. H. Steward, of London, and the late Wm. Dredge. But Col. A. T. Frazer, R. E., who has had much experience with the instrument, has found that it makes a very accurate instrument for telemetric surveying. The instrument is described as follows in "Engineering," of London, to which we are indebted for the accompanying cuts:

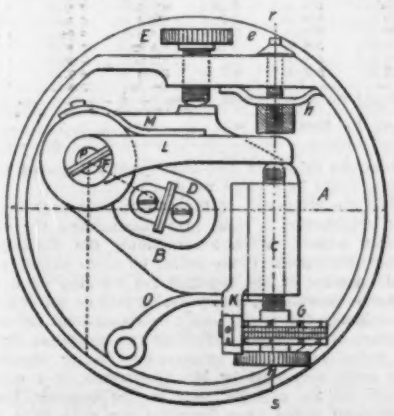


Fig. 3. Section through Omni-Telemeter.

The general view of the instrument is well shown in Figs. 1 and 2, while Fig. 3 shows a section through it. From these it will be seen that the instrument is a modification of the ordinary box sextant, but in place of the two mirrors of the instrument being parallel to each other, when the graduation reaches O, the mirrors of the omni-telemeter make an angle of 45° with each other in this position, so that on looking through the instrument under these conditions the eye of the observer occupies the apex of a right angle, the sides of which are formed by the direct line of sight, and that seen by reflection in the two mirrors. There is still another point in which the instrument differs from the box sextant. In that instrument, as is well known,

FIGS. 1 and 2. THE DREDGE-STEWARD OMNI-TELEMETER.

one of the mirrors, viz., that known as the horizon glass, is fixed in position, while the fully silvered mirror only can be adjusted. In the Dredge-Steward instrument, however, both these mirrors are adjustable. Referring to Fig. 3, D is the mirror which is fixed in the sextant, but which, in the present instance, can be adjusted through a limited range by means of the micrometer screw E. This mirror is mounted on an arm B, which, turning around the pivot F at one end, is kept in contact with the screw E already mentioned by the spring O, and it is by moving this arm that the mirror O is adjusted. At the free end of this arm is a nut C carrying a micrometer screw with a graduated head G, as shown. The other end of this screw abuts against the arm L, on which the fully-silvered mirror P is mounted, and which can, therefore, be rotated through a small angle by turning the milled head H of the micrometer screw.

In using the instrument to take a range, as A B (Fig. 6), the observer being at B, and facing so that the mark lies on its right hand, he views it by reflection in the instrument. The line of sight from the object, reaching first the mirror P, is reflected on to the mirror D, Fig. 3, and from it to his eye. The observer now looking through the unsilvered part of the mirror tries to find some prominent object, C, which he can superimpose on the reflected image of A, without, be it understood, touching the micrometer screw H. When this is done the angle A B C, Fig. 6, is a right angle. Now putting a mark at B, he paces in the direction of C B, produced a distance B D = 50 yds., and looking again through the instrument as before he turns the milled head A until the image of the mark A is again superimposed on C. Then reading the index on the micrometer screw, and referring to a short table attached to the instrument, he reads off instantly the range A B. Usually it is impossible to get a mark C, such that the angle A B C is a right angle, without several trials, and it is here where the advantage of the omni-telemeter comes in, since it is not necessary with this instrument that the angle A B C shall be a right angle. Hence, if a point cannot be found fulfilling this condition, the observer chooses some point that nearly does so. Looking at this object and the mark through the instrument, where the latter is adjusted in its zero position, the image of the mark will be to one side or the other of it. In this case the screw E is turned round, moving the mirror until coincidence is secured, and the second observation is taken at D, Fig. 6, as before. Owing to this adjusting screw E, much less trouble is required to find a suitable mark on which to project the object whose range is sought. In the case of instruments having a fixed base angle, the observer may have to shift his position considerably before the desired coincidence is obtained. The adjustment allows base angles varying 8° on either side of 90° to be used, and it, therefore, is only in very exceptionally monotonous countries that a suitable mark cannot be obtained with comparative ease.

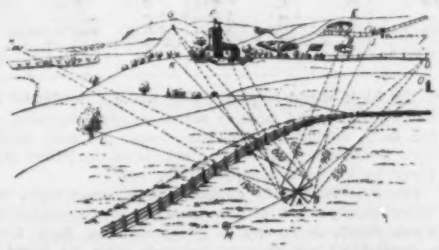


Fig. 4. Taking Distances by the Omni-Telemeter.

The instrument has been tested by Mr. John Coles, of the Royal Geographical Society, the author of "Hints to Travelers," for taking a round of distances from a central point which can be very quickly accomplished by the omni-telemeter. The best plan of doing this is indicated in Fig. 4. A stick is placed at the point A, and distances of 25 yds. measured on each side of it. Then to get any range, such as E, a siutable object such as L is taken, and the observations taken at the points B and C. To take the distance of the point G a man is sent out with a picket to O, and used as the auxiliary mark. For the range of the steeple F the mark M would be used, and J when taking H. In this way a whole round of objects can have their distances ascertained very rapidly. With moving objects two instruments are used, held by observers 50 yds.

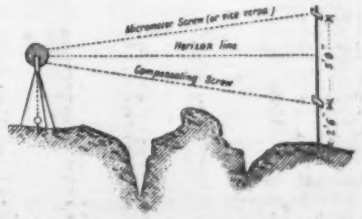


Fig. 5. Telemetric Surveying with the Omni-Telemeter.

apart, the line between them making an angle of nearly 90° with the object. Both of the instruments having been first set to zero, each observer reflects the other on the object by using the micrometer screw H. The range is then got by adding or subtracting the readings of the two instruments, the sum being taken when the zero line of the two is on the same side of the zero line of the scale K, Fig. 3, and the difference when they are in opposite sides.

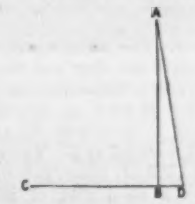


Fig. 6. Taking a Range by the Omni-Telemeter.

For telemetric surveying the following method of using the instrument has been worked out by Col. A. T. Frazer, R. E., and is illustrated in Fig. 5. The instrument is mounted on its stand in the position shown in Fig. 2, and a bright object—Colonel Frazer uses a gilt prism—is placed on the ground vertically below it by means of a plumb bob. The instrument is then set to zero. An assistant is sent out to the object, whose distance is required, with a staff having targets 5 ft. apart, the lower one being 2 ft. 6 ins. from the

ground. This target is alined with the image of the ground mark by means of the compensating screw E, and afterward the upper target is alined by means of the index screw, the reading of which then gives, by reference to a table, the distance of the staff. This method can be employed in all cases when the slope does not exceed 8°, that being the limit of adjustment by the compensating screw. At the same time the instrument can also be used to ascertain the heights of objects, the distance of which is known. For this purpose the instrument is mounted on its stand as already described, and the base of the object being reflected by the compensating screw on to the plumb bob, and then its summit by the other screw. The height of the object is then obtained from a table of rise in inches per yard. It is obvious that the instrument can also be conveniently used as an optical square, and hence, from what has gone before, it appears that it can be used almost as a universal instrument for preliminary survey work. For its original purpose, viz., that of a military range-finder, we understand it is being supplied to the Indian Government.

COST OF ELECTRIC LIGHTING AT TOPEKA, KAN.

The electric light plant at Topeka, Kan., is owned and operated by the city, and in our issue of June 16, 1892, some particulars were given of the plant and the cost of operating it. We now present a complete table of the cost of operation, which is very interesting. The plant consists of a lot and building by a railway switch. There are three boilers and three engines (worked to 235 HP.); six Jenney Indianapolis arc dynamos of 30 lamp power each, six circuits with 24.72 miles of line, and 33.5 miles of wire, supported on 943 poles 30 ft. high. The lamps are suspended between 40-ft. poles at the center of each intersection on the principal streets, and at each alternate intersection on the residence streets. The greater portion of the lamps are 1,100 ft. apart one way and 800 ft. the other; making in all 184 lamps, rated at 2,000 c. p. A test of 17 lamps showed an average pressure of 23.15 volts, and a current of 19 amperes, 439.85 watts, or 1,953 nominal c. p. The cost of lot and building was $8,559.33; plant, poles and wire, $46,888.65; making a total cost of $55,447.98. The best lump coal has been used, at an average cost of $2.75 per ton. Mr. Lewis Kingman is City Engineer, and Mr. J. B. Marshall is Superintendent of the Works. Mr. R. L. Cofran is Mayor of Topeka.

Number.	YEAR AND MONTH.	Nights Run During Month.	Hours Run During Month.	Average Number of Hours Run.	COAL. Tons.	COAL. Cost.	COST OF COAL PER HORSE POWER. Per Night.	COST OF COAL PER HORSE POWER. Per Hour.	Cost of Carbons.	Cost of Globes.	Cost of Oil and Waste.	Cost of Repairs.	Expenses Insurance, Telephone.	Pay Roll of Superintendance and Labor.	Interest on Cost of Plant at 6 per cent.	Entire Expense per Month.	Cost per Lamp per Month.	Cost per Lamp per 100 Hours.
1	November, 1889	28	340.08	12.14	236.00	$566 40	Cents. 8.60	Cents. 0.71	$110 07	$13 50	$22 15	$12 15	$32 88	$483 32	$277 24	$1,517 71	$8 25	$2 43
2	December, 1889	29	373.47	12.88	261.00	626 40	9 19	0.71	142 40	8 25	27 27	133 74	29 58	531 00	277 24	1,775 88	9 65	2 59
3	January, 1890	29	357.40	12.32	222.00	532 80	7.82	0.63	142 40	18 75	26 93	167 97	30 08	497 50	277 24	1,694 27	9 21	2 58
4	February, 1890	26	308.73	11.49	216 90	520 56	8.52	0.74	123 00	9 00	23 31	154 89	28 58	496 25	277 24	1,632 83	8 88	2 97
5	March, 1890	27	274.83	10.18	194.85	459 40	7.24	0.71	123 00	13 00	23 45	180 13	29 58	498 00	277 24	1,603 80	8 71	3 17
6	April, 1890	30	268.42	8.84	190.00	456 00	6.47	0.73	109 67	13 38	25 49	90 21	32 59	509 75	277 24	1,514 13	8 23	3 11
7	May, 1890	28	171.92	6.14	156.00	374 40	5.69	0.93	70 27	8 17	24 06	27 47	29 38	508 33	277 24	1,319 32	7 17	4 17
8	June, 1890	27	132.91	4.92	76.00	182 40	2.87	0.58	50 90	3 50	32 25	94 07	31 83	516 50	277 24	1,188 69	6 46	4 86
9	July, 1890	28	146.34	5.22	110.40	283 86	4.31	0.82	50 00	3 50	19 60	100 78	37 93	523 38	277 24	1 296 29	7 04	4 82
10	August, 1890	28	182.50	6.51	144.00	345 60	5.25	0.80	70 27	2 50	21 36	57 90	32 48	515 75	277 24	1,323 10	7 19	3 94
11	September, 1890	27	211.69	7.87	154.30	403 66	6.36	0.81	81 98	5 00	25 32	48 95	32 73	516 50	277 24	1,391 38	7 56	3 56
12	October, 1890	25	204.04	8.16	110.00	361 41	6.15	0.75	79 56	5 00	22 10	64 72	34 48	467 75	277 24	1,311 96	7 13	3 50
13	November, 1890	24	206.00	8.58	126.35	385 37	6.83	0.80	74 02	9 00	22 00	79 78	49 03	523 41	277 24	1,419 85	7 72	3 75
14	December, 1890	25	198.25	7.93	123.40	373 70	6.36	0.80	83 65	3 50	15 61	86 11	31 78	525 00	277 24	1,396 50	7 59	3 83
15	January, 1891	24	189.17	7.88	122.65	374 08	6.63	0.84	71 70	6 00	19 89	100 29	38 08	530 25	277 24	1,417 53	7 70	4 07
16	February, 1891	21	157.50	7.50	83.75	249 18	5.05	0.67	65 72	3 50	17 30	195 94	33 26	529 50	277 24	1,371 64	7 46	4 75
17	March, 1891	23	158.50	6.89	102.80	302 73	5.60	0.81	71 70	2 50	13 83	102 11	36 73	528 98	277 24	1,335 82	7 26	4 60
18	April, 1891	21	141.83	6.75	100.00	317 42	6.43	0.95	64 80	3 00	13 98	41 35	37 36	525 75	277 24	1,280 90	6 96	4 90
19	May, 1891	23	127.05	5.52	101.00	294 90	5.46	0.99	60 00	3 00	10 30	56 29	45 56	525 00	277 24	1,272 38	6 92	5 45
20	June, 1891	23	118.08	5 13	86.80	264 74	4.89	0.95	55 20	4 00	9 92	56 04	47 46	525 00	277 24	1,239 60	6 66	5 66
21	July, 1891	27	136.75	5.14	75.13	220 73	3.63	0.71	55 80	4 00	10 50	39 80	40 91	525 00	277 24	1,183 84	6 43	4 63
22	August, 1891	28	172.05	6.14	90.10	274 80	4.17	0.68	72 00	2 00	14 62	67 57	33 31	525 00	277 24	1,266 54	6 88	4 00
23	September, 1891	30	251.05	8.37	108.95	331 55	4.70	0.56	72 00	3 00	20 70	171 95	35 61	525 00	277 24	1,437 05	7 81	3 11
24	October, 1891	16	140.75	8.79	106.00	323 30	8.60	0.98	60 00	2 00	10 85	730 69	35 16	510 00	277 24	1,949 24	10 59	7 51
25	November, 1891	28	244.41	8.73	136.45	395 70	6.01	0.69	96 00	6 00	19 50	110 59	35 86	533 10	277 24	1,473 99	8 03	3 29
26	December, 1891	27	227.50	8.43	143.20	415 28	6.54	0.77	90 00	4 00	12 40	74 29	33 01	525 97	277 24	1,432 19	7 78	3 43
27	January, 1892	25	214 33	8.57	142.40	412 96	7.03	0.82	84 00	4 00	12 62	147 75	34 06	523 75	277 24	1,496 38	8 13	3 80
28	February, 1892	23	204.00	8.87	160.40	465 16	8.60	0.97	79 20	4 50	12 47	27 87	34 71	525 00	277 24	1,426 15	7 75	3 80
29	March, 1892	24	190.35	7.93	134.60	390 34	6.92	0.87	72 00	3 00	12 33	88 87	33 06	525 00	277 24	1,401 84	7 62	4 00
30	April, 1892	22	148.05	6.73	103.15	299 14	5.78	0.86	66 00	10 00	7 44	260 15	34 71	527 25	277 24	1,481 93	8 05	5 44
31	May, 1892	27	171.08	6.33	107.10	310 59	5.05	0.79	66 00	29 25	16 44	54 97	33 86	525 00	277 24	1,313 25	7 13	4 17
32	June, 1892	22	117.50	5.34	78.50	227 00	4.39	0.82	48 00	6 00	8 65	674 93	39 56	525 00	277 24	1,806 38	9 81	8 35
33	July, 1892	25	126.91	5.07	78.75	228 38	3.88	0.76	48 00	2 00	7 83	48 90	30 98	525 00	277 24	1,166 31	6 34	4 99
34	August, 1892	26	156.83	6.03	97.50	272 85	4.46	0.73	60 00	6 00	11 94	82 92	35 66	528 22	277 24	1,274 83	6 92	4 41
35	September, 1892	25	192.00	7.68	124.00	355 54	6.06	0.79	60 00	6 00	11 04	104 25	35 11	531 64	277 24	1,374 82	7 47	3 89
36	October, 1892	27	202.75	7.51	134.87	391 12	6.16	0.84	84 00	6 00	12 00	221 71	34 86	536 00	277 24	1,562 93	8 49	4 18
37	November, 1892	26	231.33	8.90	178.25	499 10	8.19	0.92	96 00	4 00	13 50	33 48	33 91	526 00	277 24	1,483 23	8 06	3 48
38	December, 1892	26	237.50	9.13	152.25	426 30	6.97	0.76	72 00	2 00	12 09	57 99	33 68	525 00	277 24	1,406 28	7 64	3 22
	Totals	970	7,022.80	7.86	5,077.60	$13,924 64	Av. 6.11	Av. 0.777	$2,981 31	$235 80	$642 70	$4,847 57	$1,329 96	$19,743 85	$10,535 12	$54,240 95	Av. $7 75	Av. $3 86
	Per cent. of total expense					25.67			5.51	0.43	1.18	8.93	2.45	36.40	19.43	100.00		

UTILIZATION OF WATER POWER IN SOUTHERN INDIA.

A proposition for utilizing the water power at the Periyar River diversion works has been submitted to the government of India by Prof. A. Chatterton, and the following is an abstract of a report on the project by Col. J. Pennycuick, R. E., Chief Engineer of the Public Works Department of Madras. Mr. Chatterton also suggested an examination of the corundum deposits of the district, with a view to ascertain if they are capable of yielding the mineral in sufficient quantities for the manufacture of aluminum.

The fact that an enormous water power would be available at Kuruvanuth on the completion of the works for the diversion of the Periyar, has long been known to all who are interested in the subject. The works are designed and intended primarily for purposes of irrigation, and the government would probably refuse to listen to any proposals which involved the subordination of irrigation interests to the utilization of the water power. The amount required to be drawn off through Periyar tunnel is in round numbers 1,400 cu. ft. per second in July, August and September, 950 cu. ft. in December, January and February; 700 cu. ft. in October and November; 500 cu. ft. in March and May, and nothing in April. It will probably be necessary in any case to provide for the entire closing of the head sluice during a fortnight or so in each year, for the purpose of examination and repair of the tunnel gates and gearing; but, subject to this necessity, it will not be difficult to arrange for a minimum quantity of 600 cu. ft. a second being sent down throughout the year, and this minimum is the true measure of the power available, as for manufacturing purposes a fluctuating water power is of very little use.

The actual fall available is about 1,000 ft., and the power which could be obtained from 600 cu. ft. a second with this fall would be about 50,000 HP. This would be available day and night, and if it were proposed, as for most manufacturing purposes would probably be the case, to work for only 10 hours out of the 24, it would be practicable, without detriment to irrigation, to send down a rather larger proportion of the daily supply during these hours. It may, therefore, be assumed that for practical work 70,000 HP. would be available throughout the year.

The best method of obtaining this power from the water (irrespective of the question of its utilization when obtained) is one of great interest, both from a mechanical and financial point of view, as there is certainly no place in the world where so large a body of water is obtainable under complete control with so great a working head. Mr. Chatterton proposes to bring the whole supply by a steel-lined tunnel or inclined shaft 10 ft. in diameter, and to distribute the power from the bottom of this shaft to 30 Pelton wheels of 5,000 HP. This arrangement, the object of which is to avoid the heavy cost of steel pipe, does not appear a good one. In the first place, it is by no means certain that sound rock would be found in the line of the tunnel throughout its whole length, and the slightest unsoundness would be fatal to the whole construction. The steel liner is, as its name denotes, a mere inside skin, and is not to be counted on for resisting the pressure of the water; it would burst at once if the support of the surrounding rock were removed.

The pressure on the inside surface at the bottom of the shaft would be over 60,000 lbs. per sq. ft., an amount not excessive for really solid rock, but exceedingly dangerous for any material short of this. The smallest unsoundness in the rock, even of a slight irregularity in the cement grouting between the face of the rock and the back of the liner, and the latter would burst. Before the work could be begun, a very elaborate and costly examination of the ground would be necessary in order to find the angle at which the shaft must be sunk in order to insure a minimum thickness of from 60 to 100 ft. of solid rock, according to a level between the shaft and the face of the rock; this examination means nothing less than the removal of the soil overlying the rock throughout the entire length of the tunnel, for no borings could be accepted in such a position, and the whole of this expense would be thrown away if it was discovered, as it probably would be, that the construction of the shaft was impracticable.

The excavation at the foot of the shaft to enable the connections between the latter and the motors to be made would be a troublesome business. There is probably not less than 50 ft. of earth gravel and bowlders overlying the solid rock (and possibly a good deal more), and this must be cut away in order to drive the connecting heading, or else a brick-lined tunnel large enough to take the 30 pipes must be driven through it. Another and very serious objection to Mr. Chatterton's proposal is that the regulating gear for starting and stopping the different motors must be at the bottom of the shaft, where it is under the full head instead of the top, where the pressure is next to nothing, as it can be with an independent pipe to each motor.

It is certain that the water must be conducted from the mouth of the tunnel to the motors by means of pipes, and the cost of these would not be so great as Mr. Chatterton supposes, for it is not necessary to use the whole available fall in one step; it can be divided into two, three or more steps, the loss of head at each step being insignificant as compared with the total fall, while the thickness and consequently the cost of the pipes would be greatly reduced.

For the utilization of the power, it is probable that Mr. Chatterton is right in recommending the use of Pelton wheels, which are certainly the simplest and most economical. If the power be made available, and the quantity of ore required for working on a large scale be procurable, it is probable that no better method of utilizing the power could be found than the manufacture of aluminum. Whether the corundum deposits of Salem are of such extent as to justify working on the scale suggested by Mr. Chatterton, is a question rather for the geologist than for the engineer, but the enterprise would be a lucrative one even on a much smaller scale.

Although the manufacture of aluminum is the most obvious and probably the best method of utilizing the enormous power available from the Periyar, it is by no means the only one; the electrical transmission of power is still in its infancy, and it is by no means improbable that before many years it will be found practicable to supply both power and light from the Periyar to the towns of Periyakulam, Madura, or even Trichinopoly. I am certain that the question of the utilization of the power derivable from the Periyar Lake is one of the highest importance, and though its solution may not perhaps be within the direct province of government, it will undoubtedly be to the advantage of the latter to give its support and encouragement to any well-considered scheme having this object in view.

CARBORUNDUM: A NEW ABRASIVE MATERIAL.

In a recent lecture of Mr. Nikola Tesla on the production of light by alternating currents of high frequency he referred to the use of a material called carborundum as the light-giving material of an incandescent lamp. The nature of this new material has just been made public by the issuance of a patent, No. 492,767, to Mr. Edward G. Acheson, of Monongahela, Pa., and it appears likely to become of no small importance in the arts.

The new material appears to be that extremely rare article in these days, a new chemical compound of simple form. It is, as nearly as can be determined, a compound consisting solely of carbon and silicon, one atom of each element to a molecule, so that the chemical symbol of carborundum is Si C.

Physically, it is a crystalline substance, very brilliant and usually of a dark color, although the color varies with the materials used in its preparation. The crystals are irregular, resembling bort, and are usually octahedral, although other well-defined forms can be found. Some of the crystals are transparent and colorless. The crystals are extremely hard and highly refractory, withstanding for a long time, at least, the action of the blast from an oxyhydrogen blow pipe. In fact, the material seems to be intermediate in its physical characteristics between the carbon crystal, the diamond, and the silicon-oxide crystal, quartz, resembling the former, however, more than the latter.

It is good evidence of the extreme hardness of corborundum that the first use to which it was applied, and that for which the inventor originally designed it, was the cutting of diamonds. Notwithstanding the old saw of "diamond cut diamond," this material was found to do excellent work on the diamond cutter's lap, and is the first material other than the diamond itself which has ever been successfully used for this purpose. Prejudice of the workmen, however, as well as the limited possible demand in this industry, led the Carborundum Co., which had undertaken the manufacture of the material, to work up trade in other directions. In June, 1891, the price was considerably reduced, and it was brought to the attention of brass and metal workers as a substitute for emery. In June, 1892, further improvements were made in the process of manufacture, increasing the output to 25 lbs. per day, and the price was reduced to $2 to $4 per lb., according to the quality purchased.

Since that time the material has been extensively applied in the construction of grinding wheels, which are being widely used, as noted in our issue of Jan. 26. The Westinghouse Electric Co. alone uses several thousand wheels per month in grinding in the stoppers of its new lamps. The advantage over emery is in the much greater rapidity of grinding, which overbalances the increased cost of the material.

It may be said that further reductions in the cost of material may be expected, so far as they will operate to increase the demand for it, as the process of manufacture is simple and the materials are inexpensive. The process in general consists of subjecting a mixture of coke with silica, or silicate of alumina and a flux of common salt, to the action of the heat of an electric furnace. This is accomplished by forming an electric arc in the midst of the mass of material. When the chemical action is completed the products are removed from the furnace and the carborundum is freed from impurities by breaking it into small pieces and washing and drying it. The different sized crystals are then graded. The company is now building three additional furnaces, which will increase its output to about 500 lbs. per day. The applications of the material for cutting and polishing glass, porcelain, steel, cast iron and other hard materials are steadily increasing, and the new discovery promises to be of great and permanent importance in the arts.

There are at present 112 cities and towns in France which have telephone systems, according to "Neuzeit." When the telephone system of France passed into the hands of the government there were 11,440 subscribers, which number has since increased to 18,191. The total revenue from this source in 1892 was $800,000, of which amount nearly two-thirds was paid by the city.

THE GRAY TELAUTOGRAPH.

Prof. Elisha Gray, whose selection as the head of the electrical congress to be held at the World's Columbian Exposition is significant of his standing among American electricians, has recently perfected a new system of electrical communication by the use of an instrument which has been christened the telautograph. This almost magical instrument effects instantaneous communication in writing, between two persons, by a fac-simile reproduction of the original writing, effected over a single wire. The sender writes his message on the tablet of the transmitting instrument, and a stylographic pen on the receiving instrument at the other end of the line duplicates every motion of the sender's pencil, including lifting and returning to dot an i or cross a t, giving a very perfect reproduction of the original writing on the tablet of the receiving instrument. Fig. 1 shows a sample of the record made by the receiving instrument, reduced in size one-half. Figs. 2 and 3 are perspective views of the receiving and the transmitting instruments, respectively.

The mechanism is simple in its general principle. From the sender's pencil run two fine cords which wind around drums on either side of the tablet. A light spring on the drum shafts keeps the string always taut, and evidently every movement of the pencil causes one or both of the drums to rotate. On the receiving instrument are two similar

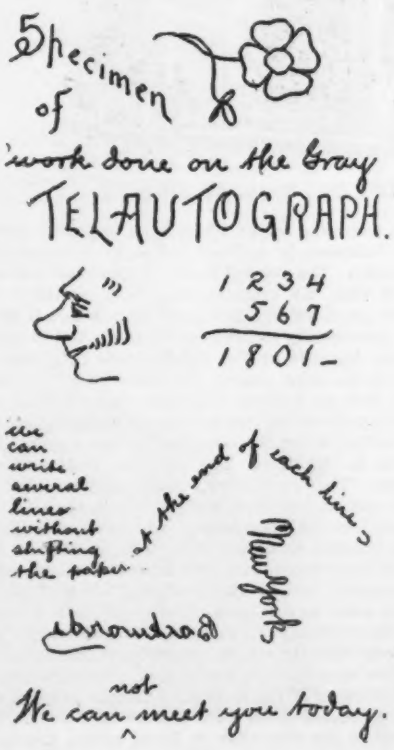


Fig. 1. Specimen of Work Done on the Gray Telautograph.

drums, and by a series of electrical impulses these drums are made to rotate in exact unison with those on the sending instrument. The cords which wind on the drums of the receiving instrument are each joined to an aluminum rod, which is forced outward by a spring as far as the slack of the cord will permit it to go. Thus, the winding and unwinding of the cords on the drums of the receiving instrument causes a stylographic pen at the junction of the two aluminum rods to follow every horizontal motion of the pencil at the distant end of the line.

To effect the next necessity, that the pen point should touch the paper only when the pencil touches it, the tablet on which the sender writes has an exceedingly small vertical movement. When pressed down by the pencil in writing, a circuit is closed which allows the recording pen at the farther end of the line to drop to the paper. When the pencil is lifted from the paper the circuit is broken, and the pen on the receiving instrument is lifted slightly above the paper, so that whatever horizontal movement the pencil at the other end may make, as in going from one word on one line to another, or in dotting i's and crossing t's, as stated, the pen will follow the movement, but without making a mark on the paper.

The stylographic pen used on the recording instrument is much more tractable and reliable than the stylographic pens in common use, and it is claimed to give no trouble by blotting or drying. The current required to work the instruments is said to be no greater than that used with the ordinary Morse instrument, and no trouble is experienced in working over long distances, nor in working as many instruments as desired on one circuit. The record on both instruments is made on a continuous roll of paper 5 ins. wide. At the end of each line the sender moves a lever which raises the paper for the next line, mechanically on his own instrument, and electrically on the receiving instrument at the other end. The writing may be fine or coarse, within reasonable limits, and letters, signs or sketches—in fact, anything which the stylographic pen could do if guided by hand—can be transmitted. The chief limitation of the instrument is the matter of speed, its limit being claimed to be about 35 words per minute in an expert's hands, and a considerably slower speed in ordinary use.

Fig. 2. The Receiving Instrument.

The uses proposed for the instrument are manifold. It can take the place of or be worked on the same circuit with an ordinary telephone. An exchange could be established similar to a telephone exchange, and at no greater expense, the subscribers communicating with each other by writing instead of by speech, or by either method if the circuits were provided with both instruments. A very important use of the instrument will be for the transmission of messages where absolute accuracy is important, such as the transmission of train orders, or communication between the different departments of a large manufacturing or mercantile establishment. It is a familiar saying that the best way to avoid mistakes is to give orders in writing. This instrument makes it possible to do this instantaneously at any desired distance. It also has the great advantage of requiring no attendant at the receiving end. Any number of messages can be written in order, as during the night, and they remain there until they receive attention. It is true that other instruments have been invented for transmitting autograph writing electrically, such as the Edison electric pen,

Fig. 3. The Transmitting Instrument.

which wrote on a sheet of chemically prepared paper, but its expense, complexity and slowness made it of little practical utility. Several forms of electric typewriting machine have also been invented, consisting of a transmitting typewriter at one end of a line actuating a similar typewriter at the other end. The printing telegraphs of House, Hughes, Phelps, Essick and of Professor Gray himself, as well as the familiar stock tickers, are examples. The telautograph, however, is the first instrument for fac-simile reproduction of handwriting which is simple and practicable for general use.

Fig. 4 illustrates the factory which has been erected at Highland Park, Ill., near Professor Gray's residence, and which is worth notice as one of the extremely rare instances of a building for manufacturing purposes being made architecturally pleasing. We give also a portrait of Professor Gray himself, whose fame for his work as

FIG. 4. FACTORY OF THE GRAY ELECTRIC CO., HIGHLAND PARK, ILL.

the inventor of the telephone is hardly dimmed by the fact that the claims of another were preferred by the courts.

Among all the recent remarkable electrical inventions, there is hardly one which seems more truly marvelous than this, and the results of its practical introduction on a large scale will be watched the world over with great interest. Whether practical difficulties of real moment still remain to be conquered cannot be asserted with confidence in advance of this wide experience, but so far as outward indications and the beliefs of many expert electricians can be trusted, the machine is already in perfect shape for use, and improvable only in trifling matters of detail, if at all. No doubt the same difficulties may have to be conquered in respect to long-distance transmission, as in the case of the telephone, and there are still two directions in which improvement seems desirable, viz., in the possible speed and in the freedom of vertical movement in the writing pencil. If the latter be moved jerkily, even if not very fast on an average, or if it be lifted too high from the paper when lifting it, the synchronism of movement is apt to be disturbed. But the very nature of the instrument would seem to make these two difficulties inherent in its very nature, and after all, they are small ones, and the writing is apt to be still legible even if they are somewhat infringed.

This, at least, is certain: that the recording instrument will either give a substantial fac-simile of the original or it will give nothing at all, and then there is only the small trouble of asking a repetition of the original writing. With a very little practice and caution there seems to be no difficulty in insuring an exact reproduction of the original, on a short circuit, at least.

The walking-beam of the steamer "City of Springfield," running on Long Island Sound, between New York, N. Y., and Hartford, Conn., broke in several pieces while the boat was on its eastbound trip March 21. The pieces fell into the engine room, damaging the machinery and injuring one of the engineers, but no damage was done to the hull.

An explosion of flour dust in a mill at Litchfield, Ill., destroyed nearly $1,000,000 worth of property, and was felt 25 miles away. The wreck of the mill caught fire, and the mill and two large elevators containing 20,000 barrels of flour and 200,000 bushels of wheat were destroyed. Windows were broken in all parts of the city. Several persons were injured.

ZONE SYSTEM OF RAILWAY FARES IN IRELAND.

The zone system of fares on the Cork, Blackrock & Passage Ry., Ireland, was described in our issues of March 19, and Sept. 1, 1892, and we are indebted to Mr. J. J. O'Sullivan, General Manager, for a copy of the company's report for the half year ending Dec. 31, 1892, in which it is stated that the number of passengers increased on the short journeys, and that where the traffic is not largely affected by the weather the number of passengers is steadily increasing. The company has had much trouble from bad weather for several seasons, as the excursion traffic, which is an important part of its business, is seriously affected by unfavorable seasons. The general result of operation last year was that the company was fully satisfied that with anything like average fair weather, it would be unnecessary to increase the rates, and that they could be kept at the popular rate they were at when the zone system was commenced; but finding that the weather was such that it did not give the returns from Crosshaven and Aghada that was expected, it became necessary to make some alteration in the rates. The directors considered two plans. They considered whether they would divide the system into three zones: No. 1, Cork to Passage; No. 2, Passage to Queenstown and No. 3, Queenstown to Crosshaven. The other plan they considered was to leave the zone system practically untouched, and by the small addition of 2 cts. on each zone, they calculated they could pull up—even if the weather should not improve, that they would recoup their losses on excursion traffic to Crosshaven, and, in fact, get a good average return on the working of the system. This was adopted, and the increased rates were started on Nov. 1. Previous to the alteration in fares, return tickets at single zone fares, viz., 10 cts. and 6 cts., were issued between certain stations not more than three miles apart, and for a single journey between the same places the same amount was charged. Now, the fares for distances under three miles on any part of the system are only 6 cts. first class and 4 cts. third class. As we have already stated, this is not really the zone system, but is an adaptation of the American plan of uniform fares for short distances.

THE UTILIZATION OF WATER POWER AT THE MINNEHAHA FALLS.*

When I came to this town, early last spring, I visited the Minnehaha Park and estimated the power of the falls at that time to be about 1,500 HP. The water power is variable, and, of course, in the spring the maximum quantity flows over the fall. Nevertheless the importance of such a power, even if only a smaller part of it could be utilized, was striking enough to encourage observations last summer and fall, which proved that the quantity to be relied upon during that whole season was, according to my estimate, always above 100 cu. ft. per second, and, mostly, went up to about 150 cu. ft. This was sufficient reason to make investigations as to the drainage area, rainfall, etc., and the general conditions of the Minnehaha Creek. As a result, I made a preliminary estimate for a scheme to utilize the power, and submitted my project to the Park Board of Minneapolis, in October, 1892, stating that the intention was to store the water of the creek in one of the lakes above the fall, to use a liberal quantity (more than the average) of the same during a few hours of Sundays and a few week days, and to utilize the rest for power purposes.

The considerable income to a water power company from said water power, will enable the same to spend several thousand dollars yearly for embellishing the park.

The scheme set forth in this letter to the board met with considerable opposition, the especial objections being that the natural beauty of the waterfall and its surroundings would be spoiled, and that the power would not be reliable, and would not be of such an amount as to encourage capitalists to invest in such an enterprise.

In order to show how in the present instance the natural beauty of the waterfall and its surroundings could be preserved, and even increased, I worked out a preliminary scheme for the power plant by which the arrangement would in no way spoil the natural beauty of the fall or its surroundings, because it would scarcely be noticed by the public except by the omission of the water flow during the long period of time when the public generally does not care for it.

Assuming 100 cu. ft. per second as the minimum quantity of water in the creek during the day and night, and storing the water in Rice Lake when it is not wanted at the falls or in the water-works, there would remain a quantity of water at the works during ten hours sufficient to furnish 1,640 HP., which, assuming the price of power, as offered by the Brush Electric Light Co., at $75 per mill power (the mill power at 5 HP. during 10 hours per day throughout the year) gives a yearly income from available water power of $24,600. The cost of construction is estimated at $35,085. The operating expenses at $7,750 would leave a net income of $16,850.

As the area of the Minnehaha Creek corresponds to a much larger average water supply and it seems very easy to store the water in the lakes within the drainage area, so as to have a constant supply throughout the year, it is probable that a larger investment of capital for the extension of the water power might be made at once or later, with a view of similar paying results.

As I had no opportunity to observe the creek in winter I depend on others for information, which seems to show that during at least four winter months only a quantity far below 100 cu. ft. per second could be relied upon. Assuming, therefore, that only 50 cu. ft. could be relied upon during four months of the winter, the remainder would have to be stored up in the upper lake, whence it could be drawn at need. The cost of such construction is not included in the above mentioned sum of $35,085. But we may assume that during four months one-half of the power would have to be supplied by steam, and calculating on the actual value of power in this locality, where plenty of steam power plants are working, the estimate of cost of construction and of rentable value would show a cost of construction of $35,085, plus $31,500; total, $66,585, with yearly expenses at $12,700. This with a yearly income of $73,800 for power shows a net income of about $61,100 per annum. The foregoing estimate will, I hope, answer fully the objection as to the financial results of the enterprise.

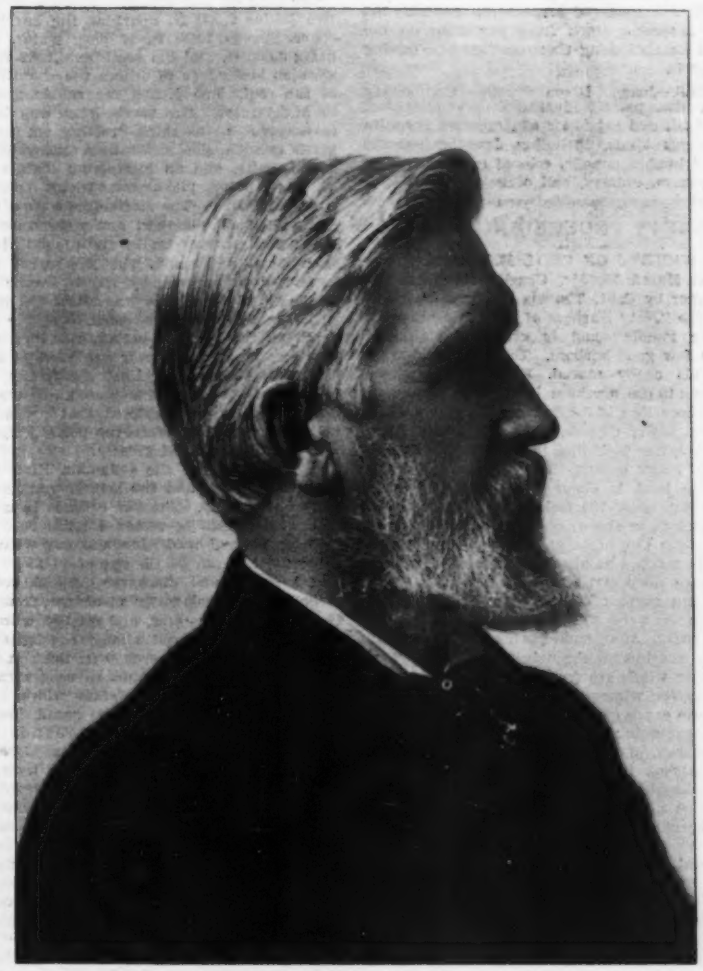
* Abstract of statement made by Charles Steiner, before the Civil Engineers' Club of Minneapolis, at its January meeting.

A locomotive boiler explosion occurred March 18 at Mahanoy City, Pa., on the Philadelphia & Reading R. R. The engine was standing on a side track. Two men were fatally injured. Another locomotive boiler explosion occurred March 18 near Butte, Mont., killing three men and injuring another. The engine was owned by the Montana Union Ry. and was going up grade with twelve cars for one of the Anaconda mines. It had stopped at a tank to take water when the accident happened.

The Atchison, Topeka & Santa Fe R. R. has decided to equip at once all of its sleeping-car service with the Pintsch system of compressed gas; and we are informed has adopted this light as its standard illuminant for passenger coaches.

The loss of the White Star freight steamer "Naronic" is one of the most notable marine disasters which has occurred for some time, in view of the fact that the vessel was fitted with twin screws, was of modern build and heavy tonnage, and apparently as safe from disaster as the most modern of Atlantic passenger steamships. The vessel sailed from Liverpool, Feb. 11, and on March 4 two of her lifeboats were seen by a steamer in lat. 42°, long. 46°, about 1,000 miles east of the American coast. It is hoped that some of her crew may have been rescued by some sailing vessel not yet come to port; and should this be the case, further news of the cause of the wreck may be obtained. The "Naronic" was built by Harland & Wolff, in 1891, was

one of the largest freight steamers afloat, measuring 6,594 tons, and being 470 ft. long, with 53 ft. beam and 35 ft. depth. She was propelled by triple-expansion engines, but it is probable that being a freight steamer safety appliances and solidity of construction in compartment bulkheads were not given as much attention as in passenger steamer construction. Conjecture as to the cause of the loss is divided between collision, fire and some serious accident to the machinery, like the explosion of a boiler, the thrashing of a broken engine or shaft, which might break a hole in the hull large enough to sink the vessel in the severe storms which have raged on the Atlantic. Except for smooth weather the "City of Paris" would probably have gone to the bottom because of weakness of bulkheads; and if



PROF. ELISHA GRAY.

the cause of the "Naronic's" loss is ever known, it will probably be found that this same defect of construction had much to do with its loss.

PERSONALS.

Mr. G. W. Fernald has been appointed City Engineer of Portland, Me.

Mr. Edward S. Shaw, consulting engineer, Boston, Mass., has removed his office to 12 Pearl St., Boston.

Gen. Thomas T. Eckert has been elected President of the Western Union Telegraph Co., vice the late Dr. Norvin Green.

Mr. George W. Moore has been appointed to superintend the construction of a system of sewers in Rochester, N. Y.

Messrs. J. R. Brennan, H. C. Warner, and E. F. Conklin have been appointed State Railroad Commissioners of South Dakota.

Mr. James G. Dagron, M. Am. Soc. C. E., has resigned his position as Engineer of Bridges of the Baltimore & Ohio R. R.

Mr. J. H. Summer, of Amsterdam, N. Y., has been appointed Roadmaster of the Mohawk Division of the New York, West Shore & Buffalo R. R., vice Mr. James Mahan, resigned.

Mr. A. W. Stedman, Chief Engineer of the Lehigh Valley R. R. since 1883, has resigned, but will remain in the service of the company as Consulting Engineer. He has been in the service of the company for 32 years.

Mr. P. W. Croak, of the Buffalo, Rochester & Pittsburg R. R., has been promoted from Superintendent of the Bradford shops to Assistant Master Mechanic. His supervision extends over the line from Buffalo to Punxsutawney.

Mr. A. J. Frazer has tendered his resignation as Trainmaster of the Ohio & Mississippi R. R., and has accepted that of General Superintendent of the Alabama & Great Southern R. R., with headquarters at Birmingham, Ala.

Mr. E. P. Lord, Superintendent of Motive Power on the Cleveland, Cincinnati, Chicago & St. Louis R. R., has resigned. His successor will be Mr. William Garstang, who now fills that position with the Chesapeake & Ohio R. R.

Mr. Oscar Murray, Vice-President of the Cleveland, Cincinnati, Chicago & St. Louis R. R., has been elected President of the Dayton & Union R. R.

Mr. Wm. P. Rounds, Rookery Building, Chicago, has been employed as Assistant Engineer on the survey for the new water supply for Galveston, Tex.

Messrs. Yeats & Gibson, of Chicago, have been engaged as consulting engineers on the Calumet Electric Ry. They make a specialty of complicated track work.

Mr. Rudolph Hering delivered a lecture before the students of the Rensselaer Polytechnic Institute, at Troy, N. Y., March 16, on, "The Design of Sewerage Systems."

Mr. M. B. Cutter has succeeded Mr. E. Holbrook as Superintendent of the Pittsburg Division of the Baltimore & Ohio R. R. He has been General Superintendent of the Newport News & Mississippi Valley R. R. for the last two or three years.

Mr. Fred V. Fuller, who has for five years been connected with the design and construction of the Boston metropolitan sewerage system, has resigned from the engineering corps of the sewerage commission to accept the position of Manager of the Carson Trench Machine Co., Boston, Mass.

Mr. John Morton Byers, Chief Engineer of the Western Division of the Pennsylvania R. R., died at Swissvale, Pa., March 4, at the age of 61. He had been Assistant Superintendent of the Lehigh & Susquehanna R. R., Resident Engineer of the Philadelphia & Erie R. R., Chief Engineer of the Mifflin & Centre County R. R., and Chief Engineer of the Pittsburg, Virginia & Charleston R. R.

Mr. C. H. Hubbell has been appointed Superintendent of Terminals of the Chicago district of the Chicago, Rock Island & Pacific Ry., including Chicago, South Chicago, West Pullman and Burr Oak, with office in the Van Buren St. Station. The Superintendent of the Illinois Division has been relieved from jurisdiction east of Blue Island. Mr. R. B. Agnew has been appointed Superintendent of the Western Division, with headquarters at Colorado Springs, Colo., vice Mr. C. H. Hubbell, transferred.

NEW PUBLICATIONS.

PAVEMENTS, SEWERS, ETC., STATEMENTS AND ESTIMATES RELATING TO. Showing Details of Cost, Specifications and Other Information of Work Done in Memphis, Tenn. By Niles Meriwether, City Engineer. Pamphlet, 8vo, 101 pp., with folding illustrations. Published by the city.

This material has been compiled by City Engineer Meriwether as a matter of interest to the citizens and in answer to the many inquiries made regarding pavements, sewer system, etc., and similar or even more extended publication of the detail of public works in all of our larger cities would be of the utmost interest and advantage to municipal engineers. Under the head of pavements Mr. Meriwether gives the full specifications for brick, granite and limestone pavements, and for curbs, crossings and sidewalks. Under the statement of cost of paving specified streets, labor and material are separated, the item and total price and quantity are stated, and in each case a supplemental table gives the cost per square yard for each item of grading, concreting, bricklaying, sand, cement, brick, etc. Other tables show the lineal feet and square yards of the several kinds of pavement on specified streets; the depth of concrete foundations, and cost per square yard, with and without curbing, etc. As showing the scope of these statements it may be said that Memphis has 36.7 miles of paved streets, including granite and limestone pavement on concrete and on gravel foundation, brick and concrete, cedar-block, Telford, macadam and gravel. The part relating to Memphis sewers is not quite so detailed in its treatment; but a general history of the sewerage of the city is given, and tables show the dimensions, cost, etc., of the system now in use.

ALTERNATING CURRENTS: An Analytical and Graphical Treatment for Students and Engineers. By Frederick Bedell, Ph. D., Jun. M. Am. Soc. M. E., Instructor in Physics, Cornell University; and Albert Cushing Crehore, Ph. D., Assoc. M. Am. Inst. Elec. E.; Instructor in Physics, Cornell University. New York. The W. J. Johnston Co., Ltd., 8vo, Cloth, pp. 325. 112 illustrations. $2.50.

This work is a purely mathematical discussion of the theory of alternating currents. The subject is treated both analytically and graphically, and apparently with much care and thoroughness. We must confess that we dislike to see the pure mathematics of a subject discussed separately from the subject itself in a book intended for use either by engineers or students, as it is well calculated to fill the souls of the latter with discouragement except such few as are unusually blessed with mathematical talents. The authors state that "the treatment is based on simple elementary ideas and is complete in itself, so that no previous knowledge of the theory of electricity and magnetism is requisite." This is true, in a sense, just as the treatises of Weisbach and Rankine are complete in themselves, but the student who should gain his sole ideas of the nature of alternating currents from the discussion of their mathematical theory would have pretty hazy notions of their nature at the end of his course. If it be conceded that the practical value of mathematics is only as an aid to correct reasoning, then certainly the mind of the student should not be concentrated on the mathematics, but on the subject matter to which the mathematics is to be applied. In other words, such treatises as this before us ought not to be separated from the practical problems to which they are applicable. Many engineers make serious blunders through ignorance of physics. It is a subject with which an engineer cannot be too familiar. But there are few engineers who blunder through ignorance of mathematics, and there are many whose brilliant rea-

soning powers have enabled them to solve difficult practical problems without the aid of the higher mathematics.

THE HANDY SKETCHING BOOK, for Engineers and Draftsmen. Ruled to Eighths of an Inch, with Useful Tables. New York: Spon & Chamberlain; pp. 80, 5×8 ins. $0.25.

The "useful tables" of this sketch-book are only three small ones of no great probable utility, but the sketch-book itself is certainly a handy one for many uses. The ruling is by lines of uniform weight, which probably is preferable, though for certain uses it is handier to have every fifth, eighth, tenth or twelfth line heavier. We have often before commended the use of ruled cross-section paper for sketching purposes, and this for many uses is in very convenient form, though for others the gage would be too small for convenience.

KING'S HANDBOOK OF NEW YORK CITY. An Outline History and Description of the New American Metropolis. Boston, 1892; Moses King; 8vo, ornamental cloth; pp. 928; 850 illustrations; price $1.

The contents of this book are quite clearly indicated in its title. It is intended to serve as a handbook, and to some extent as a guide book for visitors, of the shops, hotels, theaters, churches and the various charitable, religious, social and public buildings and institutions, and especial features of interest in the city. Like all books of its character, the information is largely superficial, and not always given with a due sense of proportion according to its importance, but it is probably sufficient for its purpose. The typography and paper are very satisfactory, and there are about 850 unusually well selected and well printed, half-tone engravings illustrating the text.

JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY. Fourth Year of Publication. New York: Published annually by the W. J. Johnston Co., Ltd., office of "The Electrical World." 8vo., pp. 786, including advertising pages. $5.00.

This appears to be a very complete directory of the electrical industries, giving the titles and officials of the electric lighting, street railway and other electrical companies in each state, and in addition a slight amount of information regarding the character and extent of the plants of these companies. No summaries are presented, not even the number of the various plants listed in each state or the totals for the United States, except in connection with prices paid for city lighting, mentioned below. It seems a pity to present so much information without an attempt at a summary.

The prices paid for lighting in 134 cities of the United States and Canada are given in a separate list, with the number and kind of lights, schedule on which they are burned and miles of aerial line. Had this information been extended and summarized its value would have been vastly increased.

TOPOGRAPHICAL SURVEY OF MASSACHUSETTS. 1892. Report of the Commissioners, Messrs. H. L. Whiting, N. S. Shaler and Desmond Fitz Gerald. 8vo. Pamphlet, 25 pp.

The Massachusetts Topographical Survey Commission in this report for 1892 summarizes the work done in the year. With the exception of the State of New Jersey, Massachusetts claims to have a better survey and map of its territory than any other state in the Union. This survey was completed in 1887, but since that "preliminary edition" much detail has been added and corrected by the "town boundary survey" now in progress. On the completion of this latter triangulation the state will have the first accurate data from which to determine its total area. That there is occasion for this is shown by the existing estimates of area, given as follows by the Commission:

Borden's state map of 1844.....area	8,500	sq. m.
Popular gazetteers give.....	7,800	"
H. F. Walling's map.....	8,160	"
Coast and Geodetic Survey.....	8,336	"
Topographical Survey of 1887.....	8,313	"
Mean of these estimates.....	8,222	sq. m.
Ocean water lying within one marine league of the low-water shore-line.....	1,941	sq. m.
Total land and water area.....	10,163	sq. m.

TRIANGULAR SURVEYS FROM SINGLE STATIONS. By Augustus Knudsen, C. E., Mem. Tech. Soc. of the Pacific Coast. Chronicle Building, San Francisco, Cal. 12m. 32pp. $1.00.

In this little volume the author treats, in a very general manner, of the methods used by him in making surveys from single stations. His suggestions, cautions and directions are good; and he says that by this means he has made a contour survey of a mountain pass, 11 miles long, and involving the fixing of 4,000 points, in six weeks, including office work. His treatise, however, presupposes the possession of considerable mathematical knowledge on the part of the reader. A few more diagrams and a little more detail in describing methods would have made it a more generally useful work.

TRADE PUBLICATIONS.

ROPE TRANSMISSION OF POWER, ELEVATING AND CONVEYING MACHINERY. SAWMILL MACHINERY.—Link Belt Machinery Co., Chicago, Ill. Three pamphlets, 8vo, pp. 16, 8, 20. Illustrated.

These pamphlets show the various applications of rope transmission of power, and of link belts and conveyors of different uses, such as raising boxes and ashes, conveying coal and grain, etc., and for handling logs and lumber in connection with sawmills and woodworking machinery. One of the coal conveying plants was illustrated and described in our issue of Nov. 10, 1892.

MECHANICAL STOKER.—Kansas City Steam Specialty Co., Kansas City, Mo. 8vo, pp. 24; illustrated.

This is an illustrated descriptive pamphlet of the Vulcan mechanical stoker, in which the grate bars are inclined 18°, and have a slight reciprocating motion, imparted by cams, the quality of fuel and intensity of the fire being regulated by the speed at which the gear is worked.

MERRILL STEEL STOCK GUARD.—The Merrill-Stevens Mfg. Co., Niles, Mich.

This catalogue describes and illustrates a steel surface cattle guard which, from the fac-similes of orders given in the catalogue, appears to be very popular on such prominent and well managed railways as the Chicago & Northwestern, the Pennsylvania, the Wabash and the Delaware & Hudson. The principle of this guard is to show a space of some depth beneath the grating, thus deterring stock from venturing on the guard, as well as furnishing them an insecure footing if they attempt it.

LEAD PENCILS.—Joseph Dixon Crucible Co., Jersey City, N. J. 8vo, pp. 36, illustrated.

This is an illustrated catalogue of American graphite pencils of various kinds, including drawing pencils, carpenters' and lumber pencils, colored crayons, pencil tips and sharpeners, erasers, and other materials.

SOCIETY PROCEEDINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on March 15, Mr. Charles Macdonald in the chair, a paper by Capt. Thomas W. Symons, U. S. Engineers, on the "Jetty Harbors of the Pacific Coast," was read. The Pacific coast is generally high and rocky, and has few good harbors. The shore is formed largely of sands easily moved. From the southern limit of California to the northern limit of Washington, the length of shore line is 3,120 miles, of which California possesses 1,097; Oregon, 285, and Washington, 1,738 miles, the latter including that of the islands in Washington and Puget sounds. The slope of the ocean bottom near the land is about 4 fathoms per mile. On the Washington coast 100 fathoms depth is reached at about 20 miles from shore; on the Oregon coast at 10 miles, and along California at 6 miles. A depth of 1,500 fathoms is reached at about 60 miles from shore, giving an average slope of 25 fathoms per mile.

The main ocean current off the coast is from the northwest, producing a reflex eddy current to the northward along the coast. Along some parts of the coast, but not all, this is continuous throughout the year. The prevailing summer winds are from the north and northwest, and the severe winter winds from the south and southwest. These cause currents near the shore in the same direction, extending seaward 16 to 50 miles, of 1 to 1½ miles per hour. The tides increase in range from 3.7 ft. at San Diego, in the south, to 6.2 ft. at the mouth of the Columbia. At the head of Budd's Inlet the range of tides reaches 18 to 20 ft.

The marked peculiarity of these tides is, that in each lunar day there are two high and two low waters which are generally unequal in height and different in interval. They are called "lower low," "higher low," etc. From lower low the tide rises to the lower of the two high waters, then falls to a higher low water, rises to a higher high water, and then falls to the lower low water. Sometimes there is little difference between the "lower high" and "higher low," or practically no change for hours. The datum plane is a mean of the "lower low," and is about 1 ft. below that of mean low water.

The rock along the coast is mostly sandstone, that in the projecting points being the harder. In addition to this source of sand, the coast range of mountains at about 20 miles from shore consists mostly of soft sandstone. The visible sand along the coast consists of dunes entirely destitute of vegetation; of others covered with driftwood, upon which a feeble growth exists; and large areas are exposed at low tide. A careful study of the movement of the sands must be made in every locality where improvements are projected. In some places, as at Coos Bay, for example, the sand moves in a cycle, being first washed up on the spit, then dried and carried by the winds into the bay. The tidal currents sweep it out to sea and the waves throw it back on the bar, to again begin the round. The control of this movement by plant growth, while yet experimental, bids fair to accomplish much good.

Where the sand is heavy and coarse, the scouring of a channel through a bar is slow; but, on the contrary, when once formed, it is more stable than where the sand is light. The immense forests of the interior furnish great quantities of drift material, so that the whole North Pacific coast is lined with it. Logs 4 to 6 ft. diameter and 100 ft. long are found intermingled with stumps and other forest debris. At the mouth of a drift-bearing stream special precautions have to be taken to prevent injury to works in progress. At Port Orford, in Oregon, and San Pedro, in California, harbors are proposed for deep ships to be formed by breakwaters. Jetties have been, and are, under construction at other points.

The first jetty to be constructed on the Pacific coast was at Yaquina Bay, a narrow estuary, 20 miles long, and 115 miles south of the Columbia River; its tidal area is 5 sq. miles, and its drainage area 262 sq. miles. The average height of tide is 7 ft., and maximum range 11 ft. The mean outflow of tide at ebb is 32,000 cu. ft. per second, and the channel, carrying 7 ft. at low tide across the bar, was constantly shifting in position. A quarter of a mile out from the bar is a reef of rocks which broke the swell and acted as a breakwater. The depth inside was 4 to 5 fathoms. Examinations by boring showed that the maximum depth to be expected by scour was 18 ft. The heavy waves of winter assume a motion of translation at depths of 8 to 10 fathoms, and carry great masses of sand shoreward.

The plan of improvement adopted was to construct two jetties 2,300 ft. apart at the harbor throat, and converging to 1,000 ft. at deep water, the north one being 3,600 ft. and the south one 2,300 ft. long. These were so located as to deflect the channel to the south of the reef. The jetties are rubble mounds reaching to high water. The south jetty was built on brush mattresses 4 ft. thick, resting on sand, and the north one on the rockbed. A tramway was carried on a trestle, and an interesting feature was the use of a revolving pile-driver, which could drive piles 15 ft. in advance. The mattresses were of brush fascines and pole-bound together, and were constructed underneath the tramway tracks and around the piles, loaded with stone and sunk. The sinking of piles in sand is now done entirely by the hydraulic method. The total cost of the jetties was about $90 per lin. ft.

The result reached has been to double the low-water depth on the bar and maintain it in a good location; the least depth for a year has been 14 to 15 ft. Outside of the channel, against the jetties, great quantities of sand have accumulated. It was only when both jetties were completed that permanency ensued in the channel, as before the north jetty was finished the channel wandered greatly.

At the mouth of the Columbia River the work is about completed, and the largest vessels can now sail in and out easily. The bar extends in a curve convex to the sea, with its vertex 4 miles out. Inside, there were shoals and sand islands among which the channel ran, with a depth on the bar of 19 to 27 ft. The estimated mean tidal discharge is 1,000,000 cu. ft. per second. The fresh-water discharge from the river is 90,000 ft. at low water, and 600,000 when the river is high. A jetty, 4¾ miles long, consisting of a rubble mound built on mattresses 3 ft. thick and 40 ft. wide, was built up to low water, to concentrate the water of the river within a moderate width, and discharge it as a unit to the sea. The result has been to increase the depth at low water to 20 ft. in a single channel, thus far permanent, which is 1,300 ft. wide; at 27 ft. depth it is 1 mile wide. The jetty has cost $83 per lin. ft. The jetty, while called a low-tide jetty, has really been built 4 ft. higher, to allow for subsidence.

Other works were described, including Wilmington Harbor, Cal., Coos Bay, Humboldt Bay and Coquille River, The paper went into details of construction, the methods of carrying on the work, the use of quoins to prevent undermining, and the relative advantages of low and high jetties, the latter being considered generally preferable.

In a written discussion, Mr. Geo. Y. Wisner approved of the work being done by the government rather than by contract. Where the mattress work is kept in advance of the rock filling the former must be kept close up to the end of the trestle, to prevent scour round the piles. Captain Black, in an interesting talk upon the subject of the paper, pointed out the disadvantages of lack of sufficient appropriations to keep the work going on uniformly. With heavy sand, mattresses 40 ft. wide may suffice, but in the lighter sands, as found on the eastern coast, they must be 100 to 120 ft. wide. In one case the mattress work had to be increased in width from 50 ft. to 120 ft., to prevent underscour. It is best to keep the work in deep water, as, if it is built on a shoal, and a deep water channel forms alongside of it, the jetty may tip over. He preferred high jetties, but low jetties gave better resistance to wave motion, unless very heavy rock or hand-laid slopes are used. Mr. O'Rourke described work done at the mouth of the Wisconsin River in making a permanent channel under the drawspan of a new bridge, where the channel had formerly been very erratic. Side shoots were cut off, and training dams built of mattress work and rock. The Galveston Harbor work (Eng. News, Jan. 10, 1891) was also described.

At the meeting on April 5, a paper on "The Sodom Dam, New York," will be presented.

ENGINEERS' CLUB OF CINCINNATI.—At the February meeting, 28 members present, papers on the following subjects were read: "Suggestions on the Treatment of the Miami Canal," by Maj. L. M. Hosea. He treated the subject from an artistic point

of view, pointing out how the canal and the land on either side could be improved and beautified by borders of grass and foliage, walks and roadways, and the canal itself used for pleasure boating, as well as for transportation. The use of the water for street sprinkling, fire purposes, sewer flushing, etc., including, of course, the purification of the water, and keeping it free from contamination, were also suggested. "Peculiarities of Numbers," by Oswald Dietz. This was an explanation of the law or rule governing the fact that the square of any number cannot have as its last figure 2, 3, 7 or 8, and that the bi-square of every number which is not a multiple of 5 can have as its last figure only 1 or 6. "A Proposed Plan for the Disposal of Overhead Wires in Cities," by Col. Latham Anderson. The plan proposed was that of placing the wires directly over the sidewalk at a height of 18 ft., on suitable supports extending from poles from the curb line, about 80 ft. apart, to the buildings, and preventing the falling of the wires to the sidewalk in case of breakage by a mesh of wires with ground connection through the poles. Another plan would be the placing of the wires directly under the sidewalks in areaways, between the curb and house line. Sewer, water and gas pipes could also be so placed.

NEW YORK RAILROAD CLUB.—At the meeting on March 16, 25 new members were elected. A paper on locomotive boilers was read by Mr. W. F. Dixon, Chief Draftsman of the Rogers Locomotive Works. He advocated the use of butt seams rather than lap seams for the barrel of the boiler on account of the grooving which occurs with lap seams. The firebox end of the boiler is where the greatest difficulties in design are met. Sheets which are to be flanged should be 1-10 to 1-8 ins. thicker than other seams to allow for the thinning of the sheet in flanging. Mud rings are generally made too thin and light for the heavy load they have to carry. They should have as large a bearing surface as possible against the sheets, for obvious reasons. Broken staybolts are probably the greatest source of trouble with locomotive boilers. The best ways to diminish the trouble are to increase the size of the staybolts and the width of the water space near the top, also to use a fine thread with the top and bottom rounded instead of the sharp V thread commonly used.

There are three systems of supporting the crown of the firebox, by crown-bars, by radial stays and by the Belpaire system of staying. The old crown-bar method does well on a small size crown, on a boiler of low pressure using good feed water. When the boiler becomes so large that sling stays have to be added to support the crown bars, this method of construction becomes objectionable; the same is true when the feed water deposits much sediment, as the bars hinder it from being washed off the crown and it is liable to remain and cause burning of the sheet.

The radial stay boiler has been largely introduced to take the place of the crown-bar under these conditions. Some anxiety was at first felt regarding its safety, on account of the sharp angle at which some of the stays enter the sheets, but experience has shown that there is nothing to be feared on this score. It is a good idea to place button heads on the central six rows of stays, on the under side of the crown sheet in boilers of this class. These will assist in preventing the stays from pulling through the sheet in case it is overheated.

The Belpaire boiler has recently come into extensive use, and is the best solution yet brought forward of the problem of designing a safe boiler of any desired size which can use hard water. Of the total output of the Rogers Locomotive Works for the past two years, 68% has had Belpaire boilers. An advantage which is of no small importance to the boiler maker is that all the stays can be made of one length. A disadvantage of the Belpaire boiler over the wagon-top crown-bar boiler is that a larger proportion of the weight of the boiler is thrown on the front truck. Thus the percentage of weight of a boiler which can be thrown on the driving wheels is:

	Per-cent. of weight —of boiler on drivers.—	
Type of engine.	Belpaire boiler.	Wagon-top boiler.
4 drivers.....	61%	64%
6 drivers.....	68%	74%

The grate area of a boiler will depend on the fuel to be burned. Wood requires a deep firebox, which must go between the frames, and its area will be limited. Anthracite requires a broad shallow firebox, which can well be placed on top of the frames. Soft coal can be burned in either a deep or shallow firebox. A good method for proportioning grate area is to assume an evaporation of 6½ lbs. of water per lb. of coal and rate of combustion of 120 lbs. per sq. ft. of grate per hour. Knowing the pounds of steam the engine is to consume, the grate area can readily be found. A safer, if less scientific, way is to proportion the grate area by the grates of existing locomotives which give good satisfaction. An empirical rule which will be found to agree closely with the practice on many successful locomotives is the following: Grate area in sq. ft. = vol. of 1 cylinder in cu. ft. x 6.

Tubes should be placed not closer than 11-16 ins., or 3-4 in. apart. It makes very little difference whether the tubes are arranged in horizontal or vertical rows, notwithstanding all that has been said pro and con on the matter. It is better to use a copper ferule at each end of the tube than at the firebox end only, as the tubes can be removed for scaling much more easily. In fitting flues care should be taken that the tube surface and the opening in the tube plate are thoroughly cleaned. Otherwise there will be trouble from leakage.

In the discussion on this paper Mr. H. L. Leach said he was satisfied that a number of boiler explosions occurred soon after the boiler was overhauled and repaired, the reason being that the repaired boiler with the new stiffening and strengthening parts could not expand and contract as freely as before, and internal strains were set up.

At the next meeting on April 20, amendments to the interchange rules will be considered.

Members are requested to send by April 7, any suggestions they may have to make toward modifying, or making additions to, the "Code of Rules Governing the Condition of, and Repairs to, Freight Cars for the Interchange of Traffic." All suggestions and recommendations will be discussed at the next regular meeting, April 20; the recommendation of the club to be forwarded to the Secretary of the Master Car Builders' Association for discussion before the Arbitration Committee at the next meeting before the annual convention. Should any member desire a rule changed or modified he is requested to give the exact wording of the new or modified rule as he would like to have it, as well as explain fully why he wishes the change made, so that the committee may have full information upon the subject. Replies should be addressed to A. E. Mitchell, Supt. Motive Power, N. Y., L. E. & W. R. R., 21 Cortlandt St., New York..

BOSTON SOCIETY OF CIVIL ENGINEERS.—The annual meeting of the society was held at its rooms March 15, 63 members and 10 visitors present. The annual reports of committees were received. That of the Board of Government showed a net gain of 20 in the membership, the present number of members being 310. Ten regular meetings have been held during the year with an average attendance of 71. The result of the election of officers for the ensuing year was: President, John R. Freeman; Vice-President (for two years), George F. Swain; Secretary, S. Everett Tinkham; Treasurer, Edward W. Howe; Librarian, Henry F. Bryant; Director (for two years), Henry Manley. There were short addresses by members on the relations of the engineer to those with whom he comes in professional contact. Mr. Desmond Fitz Gerald spoke on the relations of the engineer to his brother engineer; Mr. John W. Ellis, of the engineer in politics and as a public officer; Mr. W. E. McClintock, on the engineer in his relations to the public and the press; Mr. Percy M. Blake, on the engineer as a contractor; Mr. M. M. Tidd, on the engineer as an expert witness; Mr. A. F. Noyes, on the engineer in his relations to his assistants, and President Manley closed the speaking with some remarks on the engineer as a man.

S. E. Tinkham, Secy.

NATIONAL CONFERENCE OF STATE BOARDS OF HEALTH.—A meeting of the conference will be held at the Fifth Avenue Hotel, New York city, April 5, at 10 a. m. to discuss various phases of the cholera question. The National Quarantine Commission, of which Dr. Irving A. Watson, of Concord, N. H., is chairman, and Dr. P. H. Bryce, of Toronto, Ont., is secretary, will report at this meeting. Dr. C. O. Probst, Columbus, O., is secretary of the conference.

LIVERPOOL ENGINEERING SOCIETY.—At the meeting on Feb. 22, Mr. George Farren read a paper entitled "Forces Used by Engineers Considered as Velocities; Referring Particularly to the Terrestrial Unit of Mass and to the Astronomical Unit of Mass, the Square of an Angular Velocity as the Proper Measure of Density, and the Fourth Power of a Linear Velocity as the Proper Measure of Force." Mr. Farren mentioned that Mr. Mundella, of the Board of Trade, had prepared a bill for introduction by which the C. G. S. units of measurement are about to be introduced into England—that is, that the French units of measurement are to be adopted by law and added to the statute book, drawing attention to the fact that in future all scientific measurements must be made with the strictest accuracy. He next drew attention to Lord Kelvin's popular lecture on electrical units of measurement, referring as an illustration to the astronomical unit of mass, and, alluding to the desirability of the French metrical system of measurements, he went into an investigation of the astronomical unit of mass as compared with our terrestrial units of mass, and showed the difference between the two. Further, he showed that Lord Kelvin's original proposition, that 15.3 French tons should be the measure of mass of one cubic centimetre, and further showed how any fluid, such as water, might be measured in these units. In conclusion, he quoted a letter dealing with Newton's extraordinary divination as to 5½ times the weight of water being the specific gravity of the whole globe, and a very clear illustration of the mode of dealing with the two units of mass.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on March 4, President John Birkinbine in the chair, and 50 members and visitors present, after the transaction of regular business, Prof. Joseph T. Rothrock spoke upon "Wood-Structure in Its Relation to Mechanical Purposes," with the aid of photographs and sections of wood, projected by the lantern. He explained the effect of cellular and woody fiber upon the strength and durability of the wood, pointing out the predominance of one or the other kinds of growth in different trees, and their consequent adaptability to different purposes. He explained that while the so-called annual rings might be used in counting the life of a tree, in most cases this was not an invariable rule, and one might be misled in following it in some cases. He closed by showing the distribution of the timber area in the state of Pennsylvania, and called attention to the necessity for better supervision for its protection.

Mr. Wilfred Lewis announced that at the next meeting of the club Mr. George S. Webster would exhibit, by means of the lantern, photographs of Philadelphia bridges, and give descriptions of their important features. L. F. Rondinella, Secretary.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on March 15 Mr. Robert Moore read a paper entitled "Some Notes on European Railways." By means of a chart, the mileage, cost, receipts, expenses, etc., of the railways of the world was clearly shown. The cost per mile was highest in Great Britain, $212,220, and lowest in Sweden, $29,100. The interest on capital was: 5.2% in India, 5.1% in Germany, 4.1% in Great Britain, 3.1% in the United States and 1.7% in Canada. The track and chair fastenings were illustrated by a number of photographs. This method gives a steadier track than the usual American method of using spikes only. A number of fine photographs showed the English engines and cars. The high cost of the English roads was shown to be largely due to the expensive bridges, terminals, etc. A marked feature of the English roads was the rapid handling and delivery of freight, freight received at London during the afternoon being delivered at any point the next morning. In Switzerland and Germany metal ties are being largely introduced. Arthur Thacher, Secy.

COMING TECHNICAL MEETINGS.

DENVER SOCIETY OF CIVIL ENGINEERS.
March 28. Secy., F. E. King, Jacobson Block.
MONTANA SOCIETY OF CIVIL ENGINEERS.
April 1. Secy., F. D. Jones, Helena.
SWEDISH ENGINEERS' CLUB.
April 1. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 150 La Salle St., Chicago. Secy., John Ericson.
ENGINEERS' CLUB OF PHILADELPHIA.
April 1. 1122 Girard St. Secy., L. F. Rondinella.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 3. Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 4. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
April 4. Secy., W. Halliburton.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 5. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
April 5. Secy., Arthur Thacher, Odd Fellows' Building.
WESTERN SOCIETY OF ENGINEERS.
April 5. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
April 6. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 7. Secy., E. K. Smoot, 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 7. Secy., O. Von Geldern, 719 Market St., San Francisco.
WISCONSIN POLYTECHNIC SOCIETY.
April 10. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
April 10. Secy., Waterman Stone, Baird Building.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 11. S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
April 11. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
NORTHWEST RAILROAD CLUB.
April 11. Ryan Hotel, St. Paul. Secy., W. D. Crosman.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
April 12. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
April 12. Secy, F. M Curtis, O. C. R. R., Boston.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 13. Secy., F. W. Mowbray, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
April 13. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 14. Secy., D. W. Meeker, St. Paul.
COLUMBIAN ENGINEERING SOCIETY.
April 18. Secy., F. W. Hart, Washington, D. C.
WESTERN RAILWAY CLUB.
April 18. Secy., C. F. Street, Rookery Building, Chicago.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 18. Secy., R. H. Clark, Pittsburg.
BOSTON SOCIETY OF CIVIL ENGINEERS.
April 19. Secy., S. E. Tinkham, 36 Broomfield St.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 19. Informal meeting. Secy., L. V. Carmalt, Roanke, Va.
NEW YORK RAILROAD CLUB.
April 20. "Rules of Interchange of Freight Cars." Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
April 20. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 20. Secy., C. F. Franson, Portland Block.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20. Atlanta, Ga. Secy., F. A. Charlot, Macon, Ga.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 21. 201 Washington Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 28. Secy., C. H. McLeod, Montreal, P. Q.
CENTRAL RAILWAY CLUB.
May 24. Secy., S. W. Spear, Buffalo, N. Y.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter.

VOL. XXIX. THURSDAY, MARCH 23, 1893.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

Chicago Office: Monadnock Building.
F. A. PECKHAM .....MANAGER

EUROPEAN AGENCIES:
KEGAN PAUL, TRENCH, TRUEBNER & Co. (Limited), Paternoster House, Charing Cross Road, London, Eng.
SAMPSON LOW, MARSTON & Co. (Limited). St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50; 4 months, $2.00; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

The date when the subscription expires is on the address label on each paper, the change of which to a subsequent date becomes a receipt for remittance. No other receipt is sent unless requested.

ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Our English contemporaries have devoted considerable space recently to a scheme for economizing fuel in an electric lighting plant, which has been christened "thermal storage" by its originator, Mr. Druitt Halpin. The attention of American engineers has been directed to the scheme by a paper describing it which was read by Prof. George Forbes at the recent National Electric Light Convention at St. Louis. Briefly described, the "thermal storage" system is a system of storing superheated water under high pressure in steel cylinders separate from the boiler plant. All feed water is pumped into these cylinders so that the sediment is deposited in them, and the steam supply for the engines is drawn from them. The boiler plant is run steadily at a constant rate, delivering its steam to the storage tanks and drawing its water supply from them. By this means a much smaller boiler plant will suffice, and it can be run with better economy of fuel. For example, in the central station supplying electric current to Berlin, 22 Babcock & Wilcox boilers are in use. Mr. Halpin would use only five of these in conjunction with 92 storage cylinders. Of course the first cost of such a plant would be largely in excess of that of the plant as at present arranged. Mr. Halpin estimates that the present plant at Berlin cost $182,700, while the proposed thermal storage plant would cost $258,700. The interest and depreciation account shows a balance of $3,220 per annum against the thermal storage plant, but it is claimed that by its use 7,000 tons of coal per annum would be saved, or about 15% of the total fuel consumption.

The above statement of the scheme presents it as clearly as if a great deal more space were devoted to it, and we believe the judgment of American engineers will be that there is nothing in it worth a trial, save, perhaps, the hint that in designing boilers for working under variable loads plenty of room should be given for carrying surplus water. To equalize the variations in load which occur from minute to minute, the hot water in the boiler is invaluable as a reservoir of heat. But to carry this to the extreme of reducing a boiler plant to one-fourth its size, and storing hot water to carry all loads above this limit, is altogether too much of a good thing. It will be noticed that Mr. Halpin takes no account of the cost of the extra space required for a "thermal storage" plant; and this for an electric station in the central part of a large city would be sufficient to condemn it. Again, the coal saving claimed for the system seems enormous. There must inevitably be a considerable loss by radiation in the storage of a great amount of highly heated water, and this will be nearly constant over the whole 24 hours. The extra capitalization required at the start would make the system out of the question in most cases, for it is at the start of a new enterprise that capital is most difficult to obtain.

But the really great objection to Mr. Halpin's scheme is that there are far better and simpler ways in use of doing the same thing which he proposes. "Forced draft" is a card which will beat "thermal storage" every time. Mr. Halpin assumes at the outset that a boiler worked under variable load is very wasteful; but experience on this side of the Atlantic has abundantly proved that within reasonable limits the variation in economy is not great with variations in the rate of working. The reason for this is not hard to find. As the rate of combustion increases, the fire becomes hotter and the gases enter the chimney at a higher temperature; but to offset this loss we have the fact that with the hotter fire the coal is burned with a less dilution of the air which supports the combustion, and hence the amount of heat lost up the chimney for every pound of coal burned may be no greater than with the slower fire. Again, the hotter fire causes more perfect combustion and less gas goes up the chimney unburned. In these two facts are found, probably, the chief explanation of the remarkable economy of the locomotive boiler, which, notwithstanding the numerous disadvantages under which it is worked, is able to burn 80 to 100 lbs. of coal per square foot of grate surface per hour, or even more, with as good a rate of evaporation as a common stationary boiler worked at one-fifth of this rate. As a still more extreme example, some of the highest rates of evaporation on record were made by the boilers of a French torpedo boat working under severe forced draft.

In the ordinary plan of equipping a station with sufficient boilers to carry the heaviest load with natural draft, and banking or cooling off most of the boilers as the load falls off, there is certainly considerable loss of heat, though it is doubtful if it approaches the figure assumed by Mr. Halpin. But either by applying forced draft to the whole plant, or by firing up small locomotive type boilers to meet the demand for steam during the two or three hours of heaviest load, the size and cost of the boiler plant can be greatly reduced, and a gain in economy can be made at the same time. It is true that the use of forced draft on stationary boilers it still in its infancy; but enough has been done with it to prove its economy and efficiency from every point of view, and it is being adopted by some of the best engineers with gratifying results.

We describe elsewhere a newly invented substance, which has been christened "carborundum," and which promises to be of great importance in the arts as an abrasive material, being harder than any substance heretofore known except the diamond, and but little inferior to that. At present carborundum is being chiefly used as a substitute for emery, and its advantages are proved by the fact that the present price of the material is about $2 per pound, against some 3 cts. for emery, yet the carborundum cuts so much more rapidly that it is found profitable to use it.

From the accounts given of the material, it seems probable that it can be used instead of bort or black Brazilian diamonds in the diamond drill, and may vastly extend the use of that valuable machine. In turning chilled iron or hardened steel and for knife edge bearings in instruments of precision the material may also find useful applications. The material is no less interesting from a scientific point of view than from a practical one, since no compound of carbon and silicon has heretofore existed, so far as is known. It is not impossible that some light may yet be furnished by the process of manufacture of the new material on the genesis of the diamond itself, which has always been so puzzling a problem. The formation in which diamonds are found in nature is a hydrated silicate, and the ash which remains after the combustion of a diamond has silica as a principal constituent. These things certainly indicate that the diamond was formed in nature in the presence of silica, and the discovery that a crystalline compound of carbon and silica is formed when the two elements are intensely heated in close contact is a significant one.

We may note in this connection that an English electrician named Moissan claims to have recently produced genuine diamonds in an electric furnace. He placed about 200 grains of a mixture of iron filings and carbonized sugar in a carbon crucible resting in a bed of magnesia, and the whole was put in the electrical furnace, and subjected to a heat of about 2,500 C. After heating for five or six minutes, the crucible and its contents were plunged into cold water. The metal was then dissolved with acid and a number of diamonds were found in the residue. It may quiet the fears of those of our readers who have large investments in diamonds to learn that the diamonds, like those which have been artificially produced before, were very small.

A correspondent requests information regarding the proper mode of measuring in the curved crest and foot of a masonry dam having radial joints. A contractor bid a specified sum per cubic yard for masonry in the "down-stream face of the dam," which had a convex face, and afterward claims that in measuring up the wide end and not the center of the stone should be taken. The engineer claims that the contractor should be paid on the basis of the actual number of cubic yards, without regard to the shape of the stone, except where specified; and this latter seems to be the proper basis of settlement under the conditions named. Disputes of this kind in regard to conventional rules of measurement are a frequent source of trouble in contract work, and the best way is to exclude, specifically, all such conventional rules, by specifying that "cubic yard" means an absolute cubic yard of volume, and not some imaginary quantity. In regard to all large engineering works, moreover, this practice is so well established that we doubt if any contractor could enforce any claim for constructive measurement, even if nothing was said in the contract about how the measurements were to be made. Of course, by so specifying in the contract, "cubic yard" can be made to mean anything from a pint of water to a ton of hay, but in the absence of specifications to the contrary, it means simply what it says. With "cubic feet," "perches" and the like, when used in connection with architectural works, it might possibly be different in certain localities, but even that is doubtful.

THE MAYOR OF BOSTON ON RAPID TRANSIT.

Poor Boston's rapid transit embarrassments seem to multiply instead of diminishing. Since our last issue appeared its official head has come out in favor of a brand-new elevated railway plan which he (fortunately) explains and defends in detail, with specific estimates of cost and traffic. In this latter respect his proposal tends to clarify the situation. Generalities can be met only by generalities, and generalities are rarely convincing to the lay judgment. When an eminent citizen declares broadly, with a sweeping wave of the hand around the horizon, as one declared to us last week, that, "Boston needs, and must have, elevated railways to get out quickly to its suburbs," what can one do but mildly question where and how, or else say nothing? The Mayor has now told us where and how. He has picked out what he believes to be (and doubtless with truth) the most promising single route for an elevated experiment.

Nevertheless, it gives one a vivid sense of the instability of things to find that Mayor Matthews less than a year ago was at the head of the rapid transit commission whose report we discussed last week, and which made radically different recommendations from what he now proposes. Is he so soon convinced that his action of a year ago was mistaken; and so strongly convinced that he now prefers to flock all by himself rather than to stand any longer where he and seven other eminent citizens agreed to stand last April? One may learn much in a year, it is true; but surely this change opens the door to reasonable fears that he may be again mistaken.

It is but just to the Mayor to add, however, that while his new proposition has many differences of detail, it is laid down upon much the same broad lines of policy as the late commission's report, and

therefore is by no means so radical a departure from its spirit as from its letter. It is put forward in the discharge of his official duty, and beyond doubt in the sincere desire to do the best possible for the city. It deserves considerate, respectful and perfectly fair discussion on its merits, if discussed at all, and in these columns it shall have it. These questions are becoming so important in so many cities that we make no apology for again taking considerable space to do so—even to those who care nothing for Boston's special troubles.

The Mayor's proposition is, in a nutshell, this: He proposes to start from Causeway St. (the northwest limit of the crowded district shown on our sketch-map last week) and to build an elevated railway through a new street to the north end of Tremont St. Thence he proposes to build an elevated structure through Tremont St., and on and over the Tremont St. mall of the Common, with the alternative of a tunnel under Beacon Hill, "emerging in the middle of the Common," whence it would pass onto an elevated structure. We note in passing that either of these alternatives would deface the Common vastly more than Mr. Whitney's proposed tunnel-station, discussed last week.

Thence the line passes on south through private property for a short distance, and then splits into two nearly parallel lines, which are soon a mile or so apart (as far as from Second to Tenth Ave. in New York), one of which lines terminates at Milton Lower Mills, and the other at Mattapan—both of these points being on the six-mile cirrle, nearly due south of Boston.

It will be seen from this that the proposition really is rather to build two parallel elevated lines, each 6½ miles long, united on a common trunk for 1½ miles or thereabouts in the city, than to build a single line. The total length of line proposed is 12¼ miles, with some additional branches later.

The cost of this 12¼ miles is estimated by the Mayor at $11,681,000, or $950,000 per mile, including nearly $6,000,000 for right of way, $300,000 per mile for construction, and $556,000 for interest, allowed for one year only. The 32.4 miles of New York elevated railways are represented by stock and bonds to the amount of $50,000,000, or about $1,540,000 per mile, on which they pay about 5½%, the stock ($30,000,000) paying 6%, and the rest somewhat over 4%.

The estimated patronage, which is the first of the whole issue, may be more fairly stated in the Mayor's own words:

> The population tributary to the Boston road is fully as dense as that along the Chicago lines, and is better distributed. The population resident within a half-mile of the 12¼ miles under discussion was, according to the United States Census of 1890, 234,000. It must be 260,000 now.
>
> Judging from the results attained by the elevated railroads of the city of Brooklyn, and by the so-called "Alley" road in Chicago, a conservative estimate of the patronage of the 12¼ miles of elevated railroad proposed for Boston is 100,000 passengers a day from the beginning, making the gross receipts $1,825,000 per year at five-cent fares.
>
> The operating expenses should not exceed 60% of the gross receipts, or $1,095,000; leaving as net earnings $735,000, or a little over 6% on the investment, exclusive of taxes.
>
> The patronage of such a road should, however, be very much more than 100,000 passengers a day within a short time after its completion. If the patronage of the road were 150,000 a day, it should be operated for 57½% of gross receipts, at the outside. This would give a net revenue of $1,163,438, or 10% on the investment.
>
> These estimates of the cost of operation will be seen to be conservative when it is considered that the Brooklyn roads are operated for 56% and the Manhattan system for 50% of the gross receipts. In other words, it seems to us that such a road would pay from the beginning at least 6%, taking no account of taxes.

If the last prediction should be realized, it would pay "from the beginning" a larger interest on $950,000 per mile than the New York lines have succeeded in paying on $1,540,000 per mile after 20 years' of operation, during which the traffic has more than quadrupled; but let that pass. We will review the above statements seriatim.

Plate VI. of the rapid transit report gives a valuable and ingenious map, showing the exact area on which every thousand of the 850,000 people living within ten miles of Boston have their homes. If this map may be trusted, the Mayor somewhat over-estimates the number of people living within half a mile of the proposed line, and greatly exaggerates, by implication, those who are likely to be in any sensible degree patrons of the line. Instead of there being 234,000 people "within half a mile" of either line, and by implication tributary to it, we can only discover from the aforesaid map 57,000 on the east line and 73,000 on the west line (or 130,000 in all) who live within a half-mile of the line, and also as much as ONE mile from the City Hall. Counting from the 1½-mile circle there are only 106,000 in all who live within one-half mile of either line. As for the 112,000 people whose homes are already within one mile of the City Hall, it is absurd and deceptive to count them as contributing any material traffic to an elevated line out to Milton. They will contribute a little, of course; so they will to dozens of other transit routes; but their patronage of any and all routes is only occasional, and their patronage of any one route into the suburbs is a negligible quantity in any general estimate of traffic. This is proven by New York's experience. The traffic contributed to the elevated line by residents between the Battery and Canal St., or even between the Battery and Bleecker St. (over two miles), is a most trifling fraction of the whole.

We will grant, however, for the sake of argument, that all persons on the line living more than one mile from the City Hall—130,000 in all—may be counted on as possible patrons, being 65,000 each for the two lines. But surely not all of these will patronize the elevated railways exclusively, and desert the existing lines. In quantity, if not in quality, this whole distinct is already superbly provided with transit facilities, both steam and electric, as compared with ordinary suburban areas. We count not less than 19 railway stations within a mile of the proposed route, 11 of which are within a quarter of a mile of it. On the entire area within the ten-mile circle about Boston there is already a railway station for each square mile, from which an average of 45 trains per day (both ways) reach the city in an average of, say, 25 minutes (19 to 33). The particular district in question is even better served by steam railways than the average.

Then the electric cars pervade the entire district. They give much quicker transit than the horse cars did; run much oftener, and make nearly as good time as elevated trains would, except for the delays in the congested district, which we showed last week to be readily remediable, in part, at no cost at all, and in whole, at a cost at less than a million. The street railways now do about two-thirds of the total transportation of Boston and its vicinity, and probably about the same proportion in the special district in question. Is it unreasonable to estimate that even after the elevated lines are built they will still do half of it, the elevated lines a quarter and the steam railways another quarter? If so, we will allow one-third of the total traffic of this district to the new elevated lines. No prudent and conservative man would dream of claiming more under all the circumstances, if risking his own money.

But we saw last week that the total number of trips yearly over all lines per metropolitan inhabitant is only 220. Let us repeat and elaborate our statement of the average traffic per inhabitant for the last 20 years:

Year.	Trips per inhabitant.—Steam.	Street.	Total.
1871	33	66	99
1881	38	102	140
1891	60	160	220

The "steam" figures credit to the population within ten miles of the city all the traffic by rail between Boston and the outlying universe, and are therefore in excess by perhaps one-third part. Making this correction, there results an even 200 yearly trips per inhabitant as the present rate. That of the district in question is probably about the same as the average, and we have seen that one-third of this at most, or 67 trips per year, is likely to go to the elevated lines. Allowing for some natural and immediate increase due to enlarged facilities, let us call this 80.

Now, we are ready for a little simple arithmetic. Multiplying 130,000 possible patrons by 80 trips per year we have 10,400,000 probable five-cent trips per year, giving $520,000 probable gross revenue per year. Dividing this by 365, we have 28,500 probable trips per day, or $1,425 per day.

This is good liberal measure. Contrasted with the actual figures which the Mayor gives, of 35,000 trips per day over six miles in Chicago, and 100,000 per day over 18 miles in Brooklyn, it will still be held by competent judges to be good liberal measure. It is the utmost which any prudent man familiar with transportation questions would dare to count upon or even hope for as a basis for investing his own or his friend's cash. And yet the Mayor has persuaded himself on the scant grounds above quoted, and others unknown, that 100,000 fares per day, and $1,825,000 gross revenue is "a conservative estimate"; and that "very much more"—he instances 50% more—may be expected "within a short time after its completion"!

The Mayor's estimate of operating expenses (60%) necessarily falls to the ground with his estimate of traffic. We may admit it to be a fair (though not a very cautious) estimate on the basis of the Mayor's estimate of traffic; but with the real traffic, 75% at least would be a certainty, leaving only $130,000 per year to pay 1% interest on $11,681,000 of actual cash expenditure, without even a drop of water to make glad the hearts of the capitalists who may join in the "public competition" for the franchise.

We need follow the Mayor no farther. He is but the mouthpiece and the victim of an hallucination which just at this moment pervades all Boston, and especially official Boston. It is crying for elevated railways, and feels as if it could not be happy till it gets them. It seems to matter nothing that all the local conditions—the narrow and tortuous streets, the specially small business area, the small size of the city proper, the historic streets and pleasure ground to be defaced, the general "scatteration" of inhabitants in all directions which produces its lovely suburbs, the high level of its business center as compared with the abutting areas—it goes for naught that all these conditions are specially unfavorable to elevated railways, and indicate some other remedy for such evils as are real. The Boston of the moment has its alleged mind fixed upon this simple syllogism: Major premise—Boston is a great city which needs better transit. Minor premise—other great cities which have needed better transit have built elevated railways. Conclusion—Boston must build elevated railways. In the words of Boston's own autocrat, "You could not pry that out of the mind of a Boston man if you had the tire of all creation straightened out for a crow-bar," for the present, at least.

We readily admit the prima-facie force of the retort which these statements tempt; that all Boston may possibly be right and one New York editor wrong. But this is not a question to decide by counting noses; it is one of argument and fact; and when the best case which can be made (or at any rate, has been made) for any one specific project is such as that we have reviewed, what is the natural conclusion? Is it that the mood of the moment is founded upon reason, or that it is a mere temporary craze; a kind of mental influenza; which will pass away as rapidly as it came, for lack of suitable conditions to perpetuate it?

We are unable to take any other view of it than that it is a mere mental influenza. Like the "fellow who hath had losses," Boston does not seem to care much in its present mood whether losses are good things or bad things in themselves. It infers from surrounding examples that losses are befitting to its station as a great city, and losses it will have, in order to have "everything handsome about it" by the standard of Third Ave. and Fulton St., Brooklyn!

But we can tell Boston, if it will listen to us, that the fellows who have had their losses are not particularly happy over them, nor particularly proud of them. Boston has consorted too much with Chicago lately. Chicago is just incurring its losses; and we all know that it is, the world over, a delightful and exhilarating process. When to the exhilaration of the process is added that to be had from Chicago air and water and other liquids, how may wisdom come out of it? It's Hobson's choice with Chicago. It must go up because it cannot go down, without going down into the lake. Will Boston choose Hobson of its own free will because Chicago has to? It did not use to be that sort of a town. It used to lead, and not to follow like a sheep; but in these latter days —we will say no more.

WHAT IS TO BECOME OF OUR TIMBER SUPPLY?

Statistics gathered from trustworthy sources by the Puget Sound "Lumberman" tell us that the United States has about 1,200,000,000,000 ft. B. M. of standing lumber, with a present annual consumption of about 10,000,000,000 ft. B. M. This means an apparent supply for 120 years; but the rapidly increasing demand for timber may easily reduce this period to a century, and possibly exhaust it in 75 years. It is true that Alaska is credited, on very little information, with 66,000,000,000 ft. B. M. of standing timber, and British Columbia with 1,000,000,000,000 ft. more; but these are certainly not to be assumed as home supplies. The "Lumberman" gives the following figures for the aggregate of standing timber in the United States:

States.	Stumpage value.	Number ft. standing.
Washington	$269,561,329	410,333,335,000
Oregon	86,685,709	236,893,255,000
Nine Southern states	.....	280,000,600,000
Wisconsin	.....	26,560,035,520
Michigan	.....	24,140,699,199
Minnesota	.....	12,749,526,000
Pennsylvania	.....	7,500,000,000
Maine	.....	1,560,000,000
New York	.....	1,000,000,000
California	100,700,000	100,700,000,000
Montana	48,750,000	65,000,000,000
Idaho	22,500,000	30,000,000,000

In the above list the three states of Wisconsin, Michigan and Minnesota are elsewhere said to have cut, in 1892, nearly 9,000,000,000 ft. B. M., or over 14% of the aggregate amount of standing timber in these states, as given in the above list. The state of Michigan alone is credited with a lumber output, for 1892, of very nearly 3,800,000,000 ft. B. M., or over 15% of her standing timber.

While these figures of annual production may be taken as indicating enterprise on the part of timber cutters, the question naturally arises as to what the people of a century to come are going to do for lumber. Cheaper and more rapid means of transportion may enable them to go further for their supply; but it would seem wiser for the present generation of Americans to pay more serious atteition to the subject of forest planting and preservation; and in this way gain somewhat from the experience and practice of older nations. This action was long ago, forced upon the people of Europe, by the waste and carelessness of their predecessors; and it is hardly in accordance with modern methods for us to wait until we are compelled by similar causes to adopt a similar course, with all its attendant disadvantages of a short and costly supply. Forests may be made to disappear into the maw of saw mills at the rate of thousands of acres per year; but it takes many years to replace this loss; and one serious forest fire of a few weeks may cancel Nature's effort of a century in tree production.

The whole subject of timber preservation is one of time, as much as it is one of money; and the subject can not be taken up too seriously by the people and government of the United States. Some halting action has already been taken by Congress, and the President is now authorized to set aside certain parts of the public domain as forest preserves. But more active work still is needed, in the gathering and dissemination of useful and much-needed statistics on this head, of present supply and present consumption and waste. It is true that we have a Forestry Bureau as an adjunct to our Department of Agriculture; but, judging from the difficulty it has in securing from Congress the paltry sum of $40,000 for the continuation of exceedingly interesting and commercially valuable timber tests, our lawmakers yet fail to appreciate the true purpose and value of such a department. By a more liberal policy its scope of action and general usefulness might be very much increased, and it was with such a career in view that the department was originally created.

We have here only treated of the value of timber in its industrial sense; but it has been proven beyond controversy that forests are absolutely necessary as a conserver of water supply, and for this purpose their preservation or cultivation is even more generally necessary than when the timber is to be converted into buildings and fences, or used as fuel. Aside from the question of first cost, it would be better for the safety of property and life if timber were less used in our houses, and the substitutes for timber in construction are becoming constantly cheaper. But water we must have always, and no substitute for it has ever been suggested. The destruction of timber in many parts of Europe has altogether changed the habitable conditions of great areas of territory by reducing the rainfall and the storage for rainfall always provided by dense forests; and the arid regions of our own country show evidences of having been, in part at least, once covered by timber, long ago destroyed by fire or other agencies. Timberless areas permit the rapid evaporation or escape in surface streams of the water that falls upon them; are more subject to destructive wind storms, and are generally less pleasing and inviting as sites for habitation. We have enough of territory of this description now in the United States, and whatever the government can reasonably do to prevent any marked increase in its area should be done, and done promptly and with vigor and intelligent effort.

AMERICAN AND ENGLISH RAILWAY CARS.

The comparison of American and English passenger cars is a subject which has been discussed several times in our columns, and that the American system has the advantage in the discussion is shown by the introduction of American cars and American features of construction by English railways. In another column of this issue we give particulars of some new English saloon cars which are a compromise between the two systems, and as some of the English railways are sending over specimens of their most modern cars (Eng. News, Feb. 9), they seem rather to challenge comparison with the American cars.

We have never been able to see the point of the arguments in favor of the privacy of the English compartment system. A first class compartment generally seats three or four passengers on each side, separating them sometimes by padded arm rests and head rests. The second and third class compartments generally seat five passengers on each side. If there are four persons in the compartment each may have a coveted window seat, but in the intervals of reading or watching the scenery, they must perforce study each other's appearance and costume. Any other passengers in the compartment can see little outside the car, and, except in the first class, have no rest for their arms, but must sit up rigidly, with one or two people on each side, and perhaps four or five people opposite, all more or less inquisitive and critical. Any attempt to pull a hand-bag or valise from under the seat or from the baggage rack overhead is attended with inconvenience, and when the bag is opened everybody furtively examines its contents. Conversation under such conditions is neither convenient nor pleasant. There is practically no relief from this, as at any intermediate stops there is hardly time to collect hand-baggage, get out of the compartment and hunt up an empty or less fully occupied compartment, while there is the chance of being worse off than before. At each end of the compartment the person next the window and facing the engine is tacitly supposed to have the right to open or close the sliding window in the door at his or her pleasure, but the varying opinions of passengers as to the relative merits of drafts and stuffiness, with faceache from the one and headache from the other, generally result in general dissatisfaction. In cold weather there is a strong draft, even when the loosely fitting windows are closed, and in heavy rain the water frequently leaks through the roof openings for the lamps. With a compartment occupied by two people, traveling is fairly comfortable, but the average conditions make traveling uncomfortable and tiresome. Lavatories and closets are provided in some cases, but their defects have been pointed out in our issues of Feb. 7, March 28 and Aug. 9, 1891.

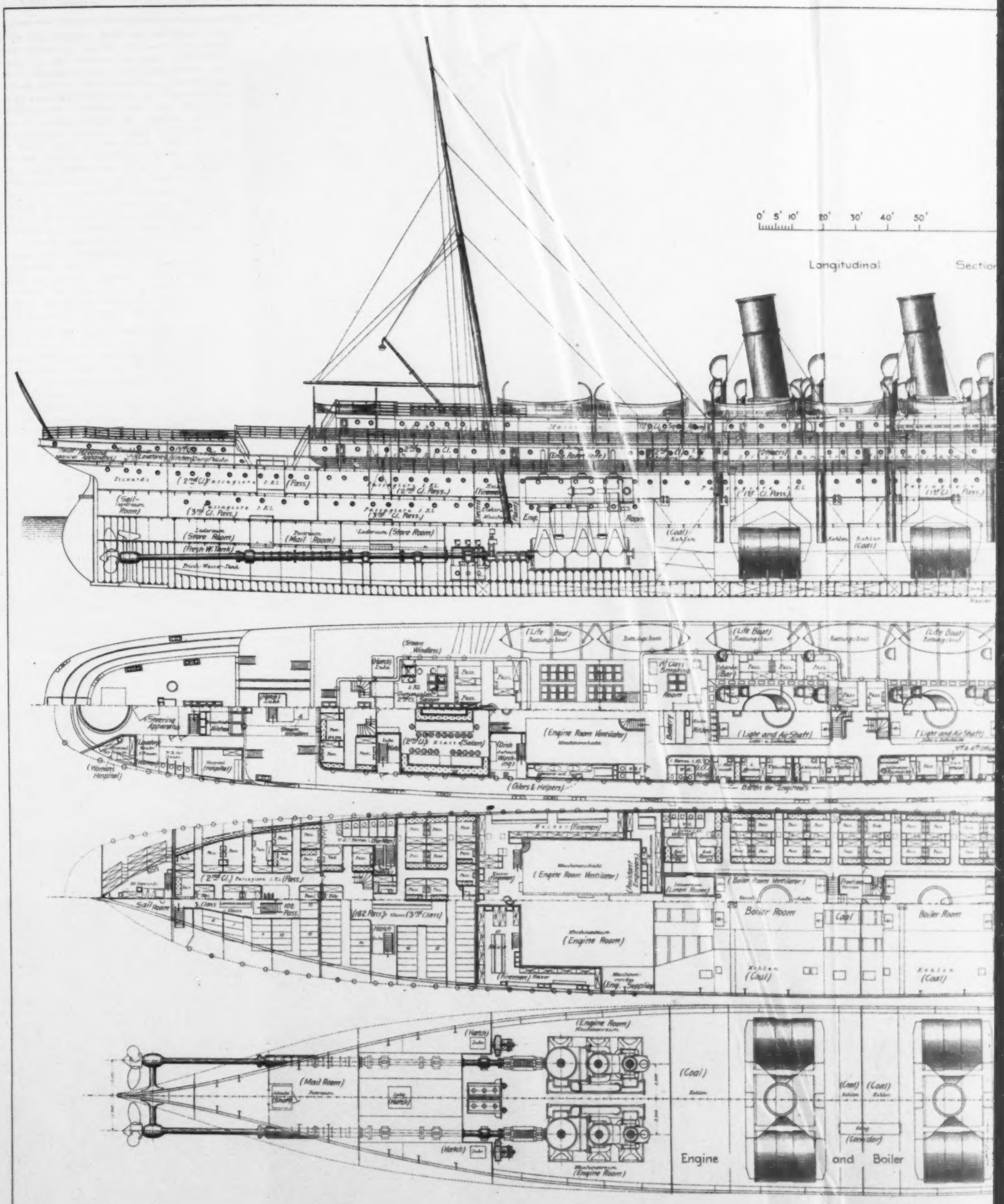
Compare the above with an ordinary American car. It is very rarely that a whole train is crowded, and if one car is full, a seat may almost invariably be found in another, without having to wait until the train stops. All the passengers sit facing in the direction the train is moving, except when a party of three of four choose to turn the back of one of the seats, and conversation is carried on or "refreshments" eaten or drank without the embarrassment of being stared out of countenance. Each passenger has a rest for one arm, there being only two passengers to each seat, and the water closet and water cooler are readily available, while the smoking car is within reach, as well as the dining car on long journeys. With a parlor car, of course, each passenger has his own seat, and all the conveniences of travel, including the smoking room and buffet, are contained within the car. The cars are heated by steam, though it must be admitted that the tendency is to keep them too hot, and they are generally well lighted, the lighting being particularly good in modern ordinary passenger cars. The ventilation is provided for mainly by the deck lights of the monitor roof, but is rarely carefully attended to, and the man who keeps his window open to let the wind blow upon the passengers in the seat behind must be admitted to be one of the occasional nuisances of traveling experience, though he rarely causes any serious annoyance. Of the two systems of traveling, the American is undoubtedly the most comfortable and convenient, and insures the most privacy, and, as already stated, the English railway men and the English public, are beginning to understand this, as well as some other features of American railway practice.

The English arrangement of seats has been adopted for the open cars of the elevated electric railway through the grounds of the World's Columbian Exposition, and for the special cars of the Illinois Central R. R., which are to carry the traffic over that road between the city and the Exposition (Eng. News, Nov. 17, 1892). This is mainly to provide plenty of side openings to insure rapid loading and unloading of the cars during many stops on a short trip, and is for temporary use only. It is not (as an English contemporary has stated) an indication that the compartment system is being adopted on American railways.

Our London contemporary, the "Engineer," says that Pullman or American cars are not popular in England, while the corridor cars, which combine freedom of movement with the side doors and the "privacy" of the English car, appears to be growing in favor. The London & Southwestern Ry., however, is adding two more Pullman cars to its equipment, which is one of many signs that the public is beginning to be educated to the appreciation of this type of car. The corridor cars have the objectionable feature of seating passengers in rows facing each other, and of restricting the light and view, as we know by personal experience of these cars. Our contemporary further says that the chairs in the very best American cars cannot compare for comfort with the roomy seats of a first class English car, a statement which is as incorrect as most of the statements made by the "Engineer" in regard to American railways. Certainly, the English first-class compartment, however comfortable its seats may be, is in no way equal in point of comfort or convenience to the American parlor car. It is also to be noted that only on the American style of cars in England can seats be retained, as in this country. With the compartment system, either with the ordinary plan or with corridors, any passenger can take any seat vacant, and a late comer has to take what he can get. Under the American system a passenger buys a seat in the parlor car, and receives a check entitling him to the use of the seat he selects, the seats of course being numbered.

The Census Office report on the nativity and percentage of the prisoners and paupers in the United States in 1890 may be briefly stated as follows: Of 82,329 prisoners, 57,310 were of purely white blood; 24,277 negroes; 407, Chinese; 13, Japanese, and 322 Indians. Of 114,620 parents of white prisoners, 45,732 were native; 60,153, foreign born, and 8,375 were unknown. Omitting the unknown, the percentage was 43.19 for the native element and 56.81 foreign. Of the 73,045 paupers in alms-houses, 66,578 were white; 6,418 negro; 13 Chinese, and 36 Indian. Of the 133,156 parents of white paupers, 45,215 were native; 63,587 foreign, and 24,354 unknown as to birthplace. Omitting the unknown, the percentage was nearly the same as for the prisoners, or 41.56% native, and 58.44% foreign born. Divided by sex, we have an aggregate of 75,924 male prisoners to 6,405 female; and in alms-houses, 40,741 men to 32,304 women.

The lot of the promoters of electric railway schemes in Great Britain does not seem to be altogether a happy one at present, all on account of the opposition of the telephone companies. In England, most of the telephone companies still use single wire lines, and use the earth for the return; hence their service is very much interfered with by the heavy earth currents of electric railway and lighting plants. It was some time

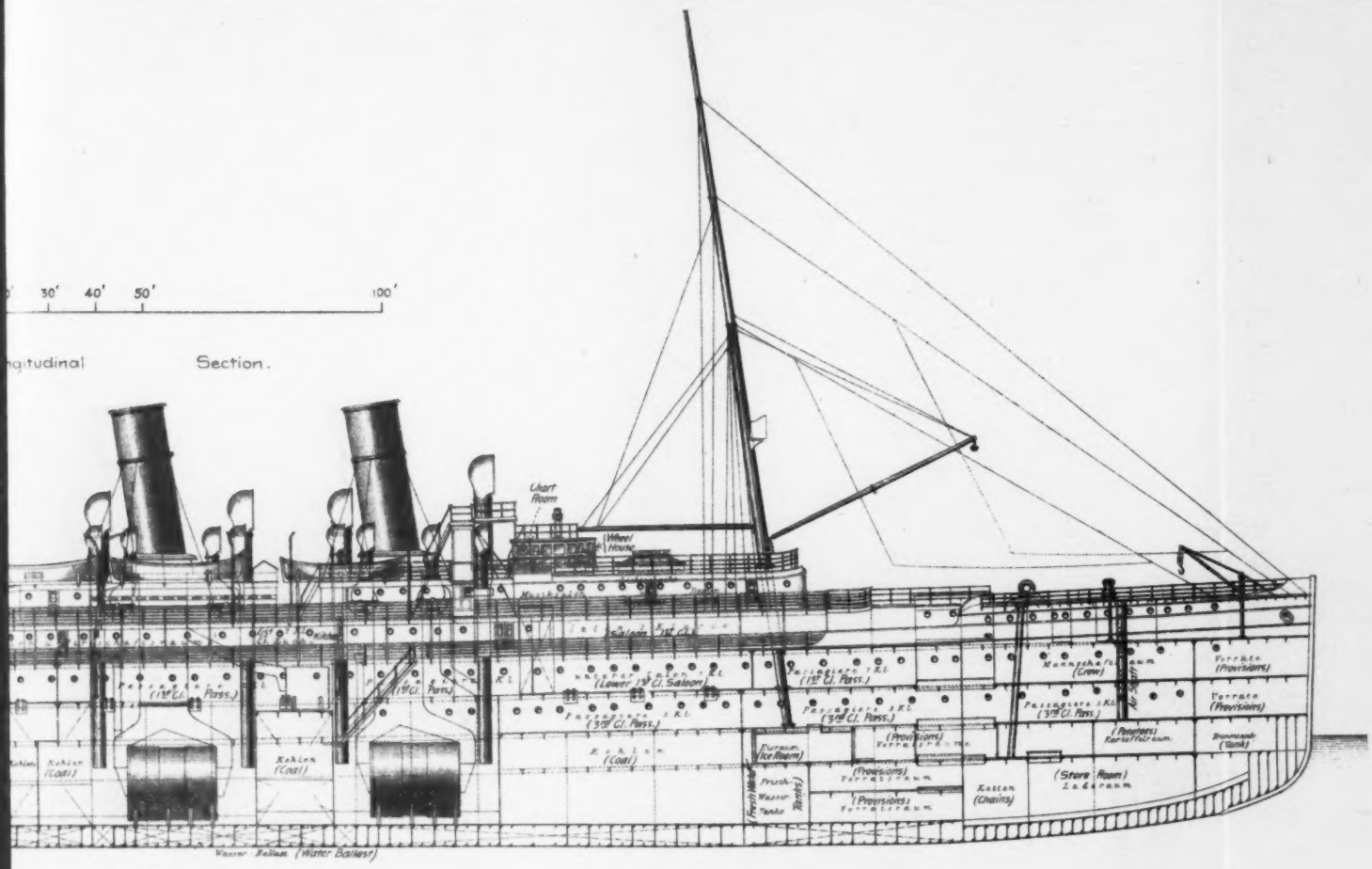


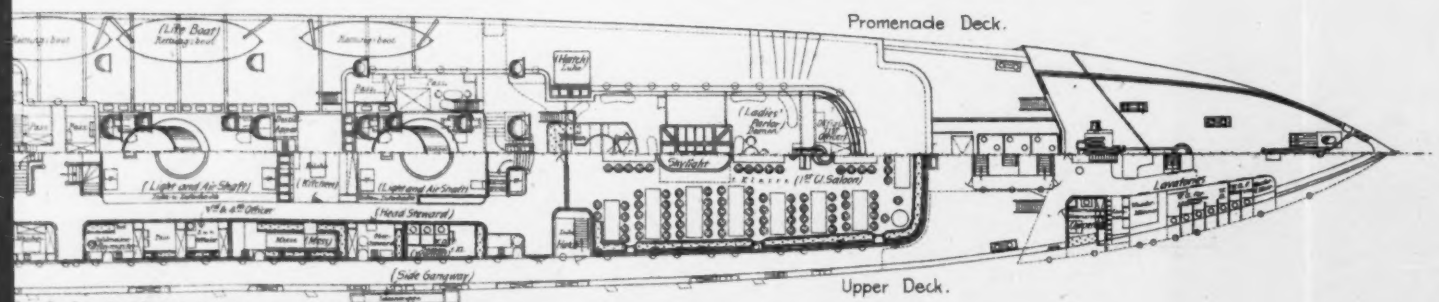
STEAMSHIP "FUERST BISMARCK"

Vulcan Work

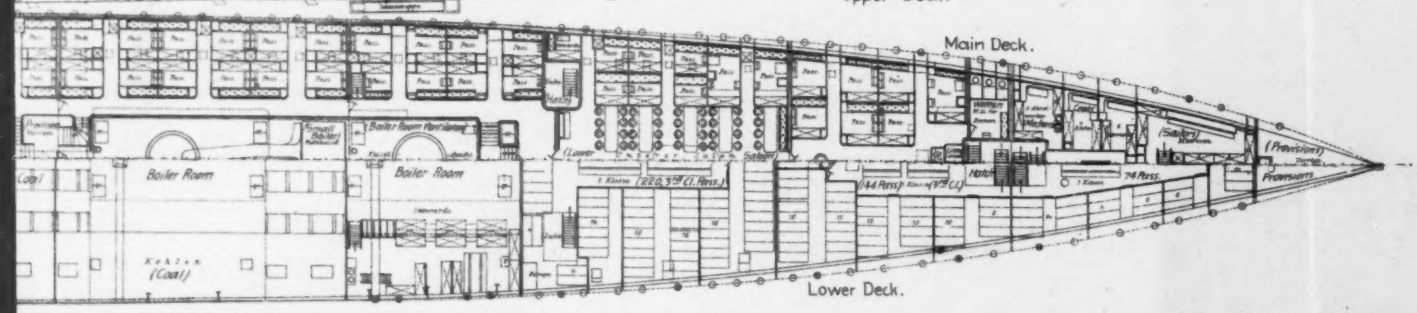
30' 40' 50' 100'

ngitudinal Section.



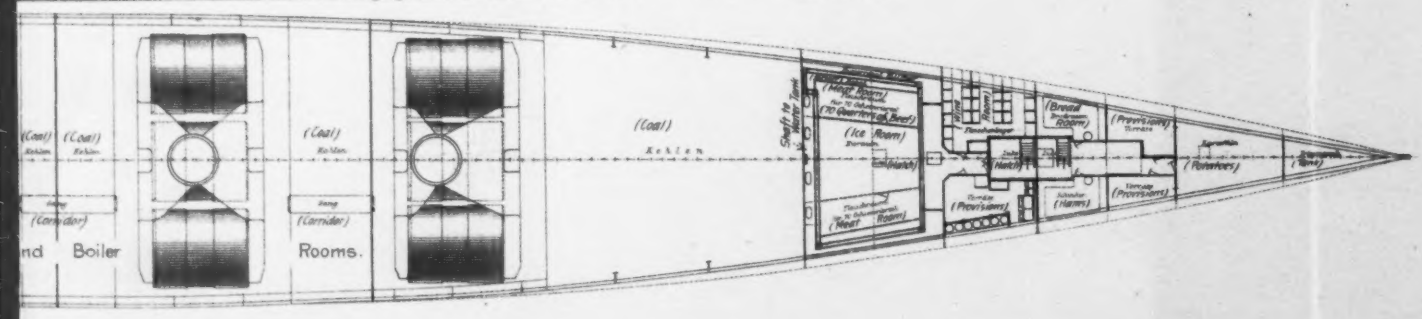


Upper Deck.



Main Deck.

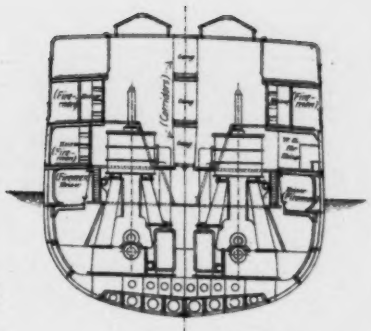
Lower Deck.



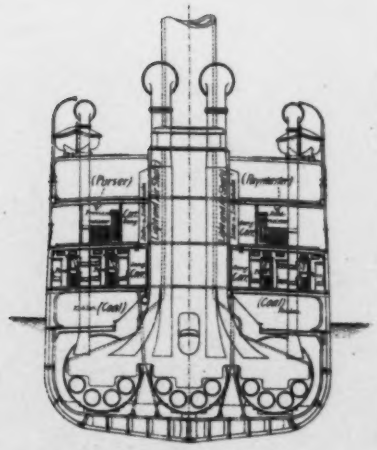
nd Boiler Rooms.

TUERST BISMARCK," HAMBURG-AMERICAN PACKET CO.

Vulcan Works, Stettin, Builders.



Cross Section
through Engine Room.



Cross Section
through Boiler Room.

CHAS. HART & SONS, LITH, 39 VESEY ST., N. Y.

ago decided in this country that the telephone companies have no exclusive right to the use of the earth for a return circuit. All parties alike have equal rights to ground their electric wires, and those whose currents are weakest have no cause of action against those who turn strong currents earthward. An English judge has now reversed this decision, and laid down the principle that if a man turns an electric current earthward and thereby interferes with the earth current used by some other person, he is liable for the damage so caused. In the particular case in question, it is true, the judge decided in favor of the electric railway, on the ground that its charter from Parliament gave it the right to create this and such other nuisances as were necessary without interference from the courts. But in a number of electric railway charters recently granted by Parliament, a clause has been inserted forbidding the company from interfering with telephone service—a clause which seemed innocent enough to the capitalists promoting the enterprise, but which now dawns on them in its full meaning. Unless the court ruling is reversed, it looks as if a number of the English railways would be forced to use the double trolley system to carry out their enterprises.

Competitive plans for the rearrangement of the wharves and docks on the Delaware River in Philadelphia, between Moore and Otis Sts., are likely to be called for. An ordinance has been favorably reported to the Philadelphia City Councils providing for such a competition and naming the resident U. S. Engineer, the resident Coast Survey Engineer, the Chief Engineer of the Philadelphia Bureau of Surveys, a member of the American Society of Civil Engineers, a member of the Harbor Commissioners and a citizen as a commission to award prizes of $1,000, $500 and $300 for the best plans submitted.

The Krupp 120-ton gun arrived at Sparrow's Point on March 18, and bids fair to arouse as widespread interest at Chicago next summer as did the similar but much smaller weapon which the same firm sent to the Centennial. The gun is to be shipped to Chicago over the Pennsylvania R. R., and a special car has been built at Altoona for the purpose, which is practically a duplicate of one built at the Krupp works that transported the gun from Essen to the seaport where it was shipped. This car has four eight-wheel trucks, and is really two cars joined together by a heavy truss, connected by center pins to each car. The weight on each car is distributed to two eight-wheel trucks. The following figures will interest bridge engineers:

	Lbs.
Weight of each single car	64,000
" " connecting truss	47,000
" " gun	270,000
Total weight of loaded car	445,000
Total wheel base of car, 79 ft.; load per ft.,	5,633 lbs.
Wheel base of each single car, 29 ft. 8 ins.: load, per ft.	7,500 "
Load per wheel	14,000 "

These are not very heavy loads per foot compared with that produced by the drivers of a large consolidation locomotive; but the total load of the whole car and of each separate single car is in excess of the heaviest loading required in Cooper's specifications. These give for the "Lehigh Heavy Grade Engine" class, 356,000 lbs. on a wheel-base of 79 ft. against 445,000 lbs. for the loaded Krupp car; and 214,000 lbs. on a wheel base of 31 ft. 7 ins., against 222,500 lbs. on a wheel-base of 29 ft. 8 ins., for each of the separate cars of which the whole car is made up.

A scheme has been prepared for an additional water supply for Brussels, Belgium, in view of increasing population and the extension of the local industries. The existing supply amounts to 7,920,000 to 9,240,000 gallons per day, and the new project provides for a further supply of from 7,800,000 to 22,000,000 gallons per day. It is proposed to obtain this from the non-navigable channel of the Meuse. A circular iron well, with regulators to provide for the fluctuations in the level of the river, would be sunk in the stream, and would have a capacity of 34,300,000 gallons daily. The well would be connected by a double steel column with an aqueduct leading to elevating works, to be situated near the Flawinne railway station. For a length of nearly two miles the aqueduct will be in solid rock at a depth of 14½ ft. below the river level. The elevating works will comprise settling basins and filters, and after being filtered the water will be pumped through 28-in. mains to an aqueduct leading to the distributing reservoir, proposed to be erected in the Bois de la Cambre, in Brussels. The capacity of this reservoir will be about 8,000,000 gallons, or slightly more than the daily consumption in the town, and the total length of the aqueduct will be 41 miles. The scheme, which has been prepared by M. Putzeys, the engineer to the Brussels municipality, provides for a double water service. The first is the present supply of potable water, and the second is the projected additional supply which would be utilized for industrial purposes, and supplied through separate mains. It is estimated that the new supply would be sufficient to meet all requirements during the next 40 years.

LETTERS TO THE EDITOR.

AUTOMATIC VERSUS MANUAL BLOCK SIGNALS.

Sir: Your correspondent, Mr. G. H. Payne, General Agent of the Union Switch & Signal Co., whose name will be found in the advertisement of that company on the front sheet of your paper, has with great fairness discounted my letter and remarks by stating that I could not discuss the matter from an independent position so long as I was the paid employee of manufacturers of signal material. This will form a sample of the kind of argument adopted by your correspondent throughout his letter (Eng. News, Feb. 16): I am wrong in writing against the automatic system of signaling because I am the paid official of a signal company; your correspondent is right because he upholds the automatic system and for the further reason that he is also the paid official of the very company who promote the automatic system.

The general tenor of the remarks of your correspondent seems to be bitter, from the fact, first, that I wrote from London, and I certainly admit with him that it is a handy and convenient spot, and secondly, from the fact that he happens to be, I presume, an American citizen and I a Britisher. I do not intend, neither have I ever adopted, the same course with reference to the Americans. I am only grateful to them for the hospitality which they extended to me on my visit, and the exceedingly kind and courteous manner in which I was received by all with whom I came in contact, and I decline to look upon your correspondent as a fair sample of the hospitable American. My object is, rather by dignified and legitimate argument to endeavor to put before the American railway public the difficulties that lie in the adoption of the automatic system.

If it will be any assistance to your correspondent I am willing to admit that I am too evidently ignorant of the subject, but I would beg to point out that I had a long discussion with Mr. Goodman, of the Union company, in Mr. Swiegard's presence, on the automatic versus the manual system in reference to its application to the terminus in Philadelphia of the Philadelphia & Reading R. R. I asked as a favor that the representatives of the Union Switch & Signal Co. might attend the discussion at the American Society of Civil Engineers on Oct. 19 last, when I read a paper on "Railway Signaling" (Eng. News, Oct. 27, 1892), and I gave them at least a week's notice. The Pennsylvania Railroad officials will certify that I carefully examined the pneumatic plant at Jersey City, the New York Central will also certify that I examined what was at that date the latest installation of pneumatic plant at Woodlawn Junction, and that in the short time I was in America I endeavored to make myself conversant with the subject. I may also state that for the last several years as each specification on pneumatic signaling has been published by the American Patent Office, I have had copies forwarded to me and read the progress as the inventions have developed.

I have looked in vain for any real information upon my letter,or any contradiction throughout your correspondent's letter. I can find nothing but very poor attempts at a repetition of old skits on railway traveling and quotations from Mrs. Trollope, and also a statement about the twinges of gout, although I am bound to say that I have never heard it cited as an English simile. In the matter of your leading article in your issue of Jan. 26, 1893, I have to say that I thoroughly indorse all that was stated, and if your correspondent wishes to enter the lists, taking your leading article as the text, I am prepared to follow him.

In his letter he says that the office of the distant signal is so well understood that it seems ridiculous to refute the statement that it is an anomaly. I have made the statement before and make it now, that it is an anomaly, and it is an anomaly in the fact that whereas it has an outward indication the same as any ordinary signal (except the fish-tail end), yet it is the only signal that may be passed at "danger" by authority. He is wrong when he states that the general use of a distant signal follows every movement of its respective home, as although a home signal must be in the "safety" atttitude, yet a home signal may be in the "safety" attitude and its corresponding distant may be in the "danger" attitude: The pneumatic system is departing from all the known uses of the distant signal in this respect.

With reference to the statement that all records show a most decided result in favor of even the poorest form of automatic signaling, perhaps it would not be asking too much if such records were stated, and also a fair comparison given with the most advanced forms of the union of the lock and block.

As I pointed out at Woodlawn Junction, on the New York Central R. R., the signals, I believe on the eastbound track, that is to say, in the direction of New York, are automatic, and their normal position is "safety"; on the other side of the line, I believe it is called the westbound direction, the signals are worked from a signal tower, although worked on the pneumatic system, and the normal position of these signals is at "danger." We have therefore on one side of the line the normal position "safety" and on the other side the normal position "danger," the signals whose normal position is "safety" not worked from the signal tower at all, and the signals on the other side whose normal position is "danger" are worked from a signal tower, the confusion arising from the fact that on one side of the line there are switches to be operated and therefore interlocked with the conflicting signals. On the other side, where there are no switches, the automatic pneumatic is provided.

It was generally understood—at all events the greatest partisans of the automatic system informed me—that under any condition it was advisable to have signalmen or operators in signal towers every five miles, even with the automatic system. Assuming the sections to be a mile apart, it would allow four automatic sections between each tower. There is no doubt that with any system of automatic signaling each train should block two automatic sections in its rear, as has been arranged on the Liverpool Overhead Ry., and there is little doubt that if two such sections had been blocked at Greenville, the accident would not have happened (Eng. News, Jan. 20).

With the union of the lock and block system, the suggestion made by you in your leading article is already carried out on certain systems, appealing to the public in this country, and if such signal, which should be the sectional signal, in any section is put to "danger" by the passage of a train leaving that section, in the union of the lock and block system the said signal cannot be lowered until the train has passed out of the section in advance.

With the sections a mile apart, as previously mentioned, and granting the signal towers in charge of operators should be placed every five miles, the average number of trains between the towers would be two, for safety sake; there might occasionally be three, or, on the other hand, there might sometimes be only one; but allowing two sections blocked in the rear of each train, the average would be two. To enable two trains to be amply protected within five miles of railway, it would only require the addition of another central box between the two, and then two trains could be so protected by the union of the lock and block system.

As it is, attendants have to be sent out to the block sections to light the lamps and to attend to what is required at the signals. In the event of the breakdown of a train in the middle of an automatic section, intimation has to be conveyed to the signal tower, which is 2½ miles away, assuming that they are as near together as five miles; and last, but not least, immediately you interpose a switch upon the main line a signal tower is needed, provided that switch has to be worked, as it ought.

Now, it is not a very great stretch of imagination to suppose that traffic in America will become as congested as the traffic in this country on the majority of the trunk lines, and I do not suppose that in this kingdom there is an average of 5% of signal cabins without a switch of some form or another connected to it, on the trunk lines. By the adoption of the automatic system, hope of any financial saving is quite out of the question, and as for safety, I think there is no question that the consensus of opinion would be largely in favor of the union of the lock and block with the improved Skyes gear.

It is a most convenient method of putting it to say that the real question is not one between the manual and automatic systems; it is purely and simply a matter of discipline. We know very well that signalmen and drivers will make mistakes occasionally, and it is the duty of all concerned to provide for these mistakes being made as far as possible by safety appliances. Your correspondent asks: Will there be more mistakes made by the engineman plus the block signal operator, or by the engineman alone? I think it would be more correct to put the question in another form, and to say: Will not the block signal operator prevent the engineman from making mistakes, or, at all events, largely assist in minimizing the results of their mistakes? I shall be prepared to show that the much-abused operator, if provided with the proper appliances—that is to say, the union of the lock and block systems, is a far more infallible machine than the automatic system of signaling. The failures of automatic signals themselves may be reported, but the cases of drivers ignoring the automatic signals when under nobody's eye are not reported.

Further, I beg leave to entirely disagree even from the editorial note attached to the letter of your correspondent. I do not think that automatic signaling will be used to any extent in the United States or any other country, because the question of the operation of switches, which all railways hope to have at most of their signal boxes (otherwise their traffic must, indeed, be small), will always reduce the advantages of any system of automatic signaling. Immediately you put an operator in a signal box to control switches it seems folly to take out of the power of that man the sectional signals applying to passenger tracks.

There is no doubt whatever that the maximum of safety is obtained by the combination or the union of the lock and block systems, on the most improved

lines. No one would be innocent enough to suppose that the interlocking system itself is any safeguard for congested traffic, and, of course, the electric interlocking system is of no use unless it is as an auxiliary to the mechanical interlocking. I agree that the purely automatic system is better than the purely manual, but the reverse has not been my contention throughout my original letter, in any of my discussions, or in this present letter.

I do not see how the automatic can be considered so neat and simple in principle that railway engineers and managers will hope for it to be adopted. It requires engines, air-compressors, dynamos, secondary batteries, magnets, wires, a perfect small pneumatic machine at every switch, a magnet at every switch, the same attached to every signal arm, a central station from which to supply the power, and pipes all the way along; moreover, none that I have yet inspected has ever provided for the breaking of the stretcher of the switches.

Finally, I may say, as Mr. Paine complains that I write from so handy and convenient a position as London, that possibly I may be in America in the summer when it would give me great pleasure to amicably discuss the relative merits of the automatic versus the union of the lock and block, at the Railway Congress at Chicago, and I hope that, should that take place, Mr. Paine, from his superior knowledge of the automatic system (and I conclude, also, his superior knowledge of all other systems), will be able to present some practical data. Faithfully yours,

John P. O'Donnell.

London, England, March 7, 1893.

(Mr. O'Donnell certainly makes some very strong points in favor of the manual system, particularly in regard to the operation of switches from towers, the check which the operator affords upon the action of the engineman, and the advantages of having men along the line in case of accidents to trains or signal plant.—Ed.)

ENGLISH AND AMERICAN LOCOMOTIVES.

Sir: In regard to the article on English and American locomotives in your paper of Feb. 16, certain persons in England appear to think it is their duty to always say, "English engines are the best," but in nine cases out of ten these writers have never been in America nor seen the working of an American engine.

If these gentlemen would make an impartial tabulated statement of facts, showing the actual working of English and American trains, much interesting information would be produced. That there are in America many fine specimens of locomotive construction is a fact beyond question, and I think one great result of the Chicago exhibition will be to show that American engines can do plenty of work as well and as cheaply as those in England. I am of course an Englishman; but I do not let that fact sway my judgment upon the working of locomotives on either side of the Atlantic.

Yours very truely,
Clement E. Stretton,
Consulting Engineer.

Leicester, England, Feb. 28, 1893.

THE EFFECT OF TAPPING FOR TURPENTINE ON LONGLEAF PINE TIMBER.

Sir: Referring to the editorial on the question of bled pine timber in your issue of Feb. 16, allow me to reply that, while simply from knowledge of anatomical and biological conditions we were persuaded before we attempted the demonstration, that the bleeding had no influence upon the quality of the heart-wood, and also that specifications for unbled timber were usually ignored, we nevertheless believe that "the importance of the decision from a practical point of view" is great enough to warrant its assiduous reiteration. For the existence of such prejudice has greatly impaired in practice the morals of trade in Southern pine on the part of the miller, and the confidence of the miller in the knowledge of the engineer or architect, who specified unbled timber, and afterward could not tell whether his specifications were obeyed. Besides, prejudice is even more difficult to remove than establish a fresh truth. Even now, after our ocular demonstration, we find that there are knowing ones who know better.

We claim to have done good service with our authoritative statement by removing one cause of uneasiness from both the producer and consumer, which allows them to look into each other's face without a lurking distrust on the part of the one, and without a qualm of conscience on the part of the other. I believe, also, that you underrate the amount of this timber used in construction, for of the round $6,000,000 worth of longleaf pine timber cut, it may be presumed that the largest part is used for constructive purposes.

Yours very truly, B. E. Fernow,
Chief of Forestry Division, Dept. of Agriculture.

Washington, D. C., Feb. 20, 1893.

(Far be it from us to underrate the practical importance of any such work as this of the Forestry Division. We merely wished to show that the very baselessness of the prejudice against bled timber had operated to nullify its effects in great measure. It is natural that it should be so. A needless requirement in a specification, the observance or non-observance of which cannot be determined by test, will generally be ignored. Nevertheless, it is well worth while to prove that the requirement results from a baseless prejudice; for every unnecessary clause in a specification weakens the force of the whole and brings professional abilities into discredit in the minds of "practical" men.—Ed.)

Sir: The deductions of the U. S. Forestry Division in regard to "boxed" pine, seem to me correct. For years it has been shipped, the consumers believing it untouched until felled for the mill. In the South engineers have used it knowingly and freely, both for cross-ties and trestle-timber.

It cannot be told from "virgin" pine, unless some cut marks of the bleeding process, or of the "box" have been left upon the timber; except in some instances, near the box, little egg-shaped hollows, from ½ in. to 1 in. in diameter, and filled with a brittle yellow deposit from the turpentine, appear. This last occurs only around boxes cut many years, and seems to be more of a "sore" than any thing else, and is only local in its effect. Only last summer, as a schooner from Florida was unloading at Norfolk, Va., one of the prettiest lots of longleaf lumber I have even seen, I asked the representative of the firm to whom the lumber was consigned; if it had ever been bled? His reply was, "No. It is all virgin pine." I said to him that he was mistaken, but that in my opinion it did not matter if he were. We then found a perfect stick of beautiful grain and appearance, and upon it, fully 10 ft. from the butt, were the marks of the "hack."

The sap is undoubtedly inferior, and the heart for 20 ft. or more, according to the tree, superior to the heart of an unbled tree. The box is cut about 2 ft. from the ground, and the tree is scarified the width of the box, and to the depth of about 2 ins. for a height of 15 ft. or more. All of this part of the tree, and for several feet above, is influenced by the scarification, and much of the turpentine goes into the pores of the heart and undoubtedly increases its life. Some sticks are so filled with this turpentine as to be almost entirely kindling wood, or light wood, as it is called in the South. I know of a piece of timber used in a trestle, in an approach to the Tar River, on the Atlantic Coast Line R. R., that was so filled with rosin as to be too heavy to float. No man can fix the limit of its life.

My experience has been that the individual piece of timber must be considered, and not whether it is "virgin" or "boxed." R. S. Neal.

Scotland Neck, N. C., Feb. 20, 1893.

MINNEAPOLIS WATER POWER.

Sir: Your issue of Feb. 2 contains a report of my statements before the January meeting of the Minneapolis Engineers' Club, which report needs rectification, although the matter has especially local interest. The yearly total deposit of rain and snow was for 1892 in this place, according to the St. Paul Weather Bureau, about 32¼ ins., while the average is about 27 ins., and the maximum runs up to 36 and 37 ins. Last year was therefore a little above the average. The water supply estimated on the spot, at several periods of the year, was always above 100 cu. ft. per second during last summer and fall, and reached 150 cu. ft. several times. It was never below 60 cu. ft. during the past very cold winter months.

The scheme, which is yet in the preliminary state, is interesting, for it promises a very good paying result on a modest capital. If instead of 100 cu. ft. only 80 cu. ft. per second should be assumed for the constant supply in construction, the rent per horse power could, of course, be changed very little. It is, however, probable that by storage in the lakes above the fall a larger minimum supply may be cheaply obtained.

Charles Steiner.

Minneapolis, Minn., Feb. 7, 1893.

COTTON BAGGING FOR TEMPORARY LEVEE PROTECTION.

Sir: An equivalent of burlaps (see Eng. News, March 9, 1893), in the form of cotton bagging, was used by me for high water levee protection in the Ashport-Gold-Dust levee, Plum Point Reach, Mississippi River, in the spring of 1887. It was very efficient, and was incorporated with the scheme of high-water police as one of its most useful features. Several miles of bagging were kept in store, and a supply was forwarded to critical points at the first intimation of danger. I did not then regard the design as especially novel, and still think that prior instances may be found.

In my report for that year I simply stated that "sacks and bagging" were supplied for the protection of the levee during the flood. Smith S. Leach,
Capt. Engrs., U. S. A.

Burlington, Vt., March 11, 1893.

NOTES AND QUERIES.

S. D. Kimbark, Chicago, Ill., asks for literature or circulars pertaining to the preserving and filling the pores of wood with resinous substances.

P. P. E., Coshocton, O., writes: Will you please inform a subscriber the weight of a cubic foot of cannel coal solid and broken?

Bituminous coal weighs about 84 lbs. per cu. ft. solid, and 47 to 52 lbs. per cu. ft. broken, of any size, loose. A cubic yard, solid, averages about 1.75 cu. yds. when broken to any market size, and loose.

Mr. F. F. Hallam asks what is the value of the term "more or less," as used in conveyances of property.

"Say that a deed is made for 50 ft. more or less; is it not limited between 49 and 51 ft.?"

The term "more or less" is used in deeds to cover errors in length due to careless measurements. It does not cover between certain limits only. For instance, if a line is described as running between two points whose position can be proved, the points will govern no matter if they are 1,000 ft. apart, while the deed reads 500 ft. more or less. Some litigation may be saved by using the phrase; otherwise it is objectionable, as it tends to careless work on the part of surveyors.

The largest shaft ever forged in America is that for the "Ferris Wheel," which is to be erected at the World's Columbian Exposition. The shaft was forged by the Bethlehem Iron Works, and was shipped on March 18. It is 33 ins. in diameter, 45 ft. 2 ins. long, and weighs 89,320 lbs. The wheel, which is to be built upon this shaft will be 250 ft. in diameter, with the top 264 ft. above the ground.

A combination of Western and Southern cast iron pipe manufacturers was perfected at a meeting in Cincinnati, March 17 and 18. The combination includes the works of the Addyston Pipe & Steel Co., at Cincinnati; the Lake Shore Foundry Co., at Cleveland; Ohio Pipe Co., of Columbus; Shickle, Harrison & Howard, of St. Louis; Dennis Long & Co., of Louisville; Howard & Harrison Iron Co., Bessemer, Ala.; Chattanooga Foundry & Pipe Works; South Pittsburg, Tenn., Pipe Works; and Radford, Va., Pipe Co., works at Radford and at Anderson, Ala. The officers elected were: President, O. C. Barber, Chicago; Vice-Presidents, C. E. Burke, Cleveland; Archer Brown, Cincinnati; Thos. Howard, St. Louis; Treasurer, Briggs Cunningham, Cincinnati. Newspaper reports place the capitalization of the combined works at $15,000,000, and state that the company will be chartered in Illinois, and will have its headquarters at Cincinnati.

Another Atlantic passenger steamer has been placed in peril by the breakage of a shaft. The "Sarnia," from Liverpool for Halifax, N. S., broke the aft crank of her engine on March 11, when about 500 miles east of Halifax. Six days were consumed in removing the broken crank and putting the crank of the forward cylinder in its place, during which time the steamer drifted northeast 234 miles. On March 17 the repairs were completed, and with the after cylinder alone, at an eight-knot speed, the run to Halifax was completed.

Two cast steel 10-in. shells, made by Isaac G. Johnson, of Spuyten Duyvil, N. Y., were tested at the Indian Head proving grounds on March 18. The shells weighed 500 lbs. each. The first was fired with an initial velocity of 1,330 ft. per second at a 10-in. nickel-steel plate, and was upset against it. The second was fired at a slightly higher velocity—1,500 ft. per second—at the same plate, and passed through the plate and backing, being broken in two in its flight. The two shells were treated by different processes, which is considered to explain their different behavior. If cast-steel shells can be made reasonably efficient, the cost of armor-piercing projectiles will be much reduced, as the cast steel can be made at one-third the cost of the forged steel. The cast steel projectiles cost about 10 cts. per lb., while the forged steel projectiles cost about 38 cts. per lb.

The armor-plate works of the Carnegie Steel Co., at Homestead, Pa., has ordered from Whitworth & Co., of England, a new hydraulic press of 16,000 tons capacity. It will be one of the largest pieces of machinery of this class in the world, and the cost is stated to be $1,000,000.

The Midvale Steel Co., of Nicetown, Pa., is engaged in the manufacture of armor-piercing shells on the Holtzer patent. The company has bought the right for the United States from the Holtzer Steel Works, of Unieux, France, and the inventor of the process, M. Haustlein, is now engaged in instructing the workmen at Midvale. The process is secret and all operations are conducted behind closed doors.

NOTES FROM THE ENGINEERING SCHOOLS.

In the matter of the contest over the Agricultural College Land Grant Fund, of Connecticut, which it is claimed should be transferred from the Sheffield Scientific School of Yale to Stow's Agricultural College, our attention has been called to the fact that in 1887 the state legislature passed a resolution that the contract with Yale constituted "a binding contract inviolably securing to said corporation the income of the fund so long as (it) shall continue to comply with the terms and conditions of said contract." The "said contract" stipulated that the interest should be devoted exclusively to the maintenance of such courses of instruction as "shall carry out the intent of said Act of Congress in the manner specially prescribed in the fourth section of said Act," and sundry other things which we need not consider, as this is the disputed point. It is claimed, with some show of reason, that the actual courses of instruction in "agriculture and the mechanic arts" at Yale are not such as the Act of Congress contemplates and requires, and that therefore any contract turning over the income of the fund to Yale is void, as not complying with the Act. At least, we so understand the grounds of the contest, and it would certainly be a monstrous doctrine that on a mere question of expediency, or of degree of compliance with the requirements of the Act, such a fund could be transferred back and forth from one college to another at the mere pleasure of the legislature.

On this question of whether or not the real intent of the law is fulfilled by the use made of the fund at Yale, a very interesting argument may be made, which we could wish might be carried up to the higher courts and authoritatively decided, to the end that the degree of compliance with the conditions of trust funds which may be demanded of those who continue to enjoy them may be more accurately fixed. It must be understood that we neither express nor have formed any opinion on the merits of this particular issue. It would be grossly unfair for us to do either without carefully investigating facts which we have not investigated at all. But, speaking generally, we have observed in regard to a number of both public and private funds enjoyed by many colleges, that the colleges seem to comply with their implied or real promise to the grantors, on accepting the gift, only in such a way as to "keep it to the eye, but break it to the hope"; and, speaking generally, we believe that public policy requires that many colleges should be held to a stricter responsibility in this respect than they are. The "Land Grant colleges," especially, are all more or less concerned in this issue.

For example, the original Act devotes the fund to colleges of "agriculture and the mechanic arts." Do colleges devoted to agriculture OR the mechanic arts comply with this requirement? Again, what are the "mechanic arts"? One branch of them, in the broad sense, is "celestial mechanics." Is a college which merely gives instruction in celestial mechanics a school of the "mechanic arts"? If not, then is a school which confines itself to earth, and gives thorough instruction in "theoretical and applied mechanics," but little or no mechanical training, a school of the "mechanic arts"?

Again, what is a "college of agriculture"? Is one which has Professors of agriculture, botany, etc., and a catalogued course in agriculture a "college of agriculture," or is it necessary, to deserve that term, even in the legal sense, that it should be a college actually frequented by students who are studying agriculture? We all know that it is possible to so manage a school or a course that it will fail or that it will succeed. Is a school or course so managed that it fails a fulfillment in law of a promise to found it? We all know also that a baby college is like any other baby; it needs money for maintenance; but it needs far more than money —that nourishing and watchful care which enables it to grow, and without which it not only ceases to grow, but dies. Is giving the maintenance, but not the care, a legal fulfillment of a promise to "adopt" a baby or a policy?

One thing is perfectly clear to us: On general principles of equity and fair dealing, the original intent of every grantor of funds for educational use should be fulfilled in spirit and in truth, so far as it is possible to fulfill it and do any good, whether or not more good might be accomplished by some other and different use of the same funds. Any college which in fact fails to do this should lose the enjoyment of the funds which it thus diverts, in the interest of public morals, if not of education. The question of what was the original intent of the land grant still remains open, however. A brief for Yale College which lies before us says that "the Act was not designed to establish schools of low grade, but to endow and maintain colleges for higher education." The words of the Act which is quoted to support this view are that "the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislature of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life."

There is room for some difference of opinion, and yet our impression is that the intent of Congress was to promote the foundation of a higher kind of industrial schools, not to train professional engineers, but to give a sound and yet inexpensive education to those who were somehow repelled from existing colleges—in other words, to extend the advantages of technical training lower down in the social and financial scale, by extending to the masses who have not the money nor—perhaps the brains—to enter upon the higher grades of professional work, the opportunity for a sound but simple training in the humbler arts, with the opportunity by contact with the higher forms of education to seek for a higher education also, if the desire to do so developed within them. If this was, in fact, the intent, it is morally wrong for any state to use the fund in any way which does not attain this end, however useful.

The Massachusetts Institute of Technology has made an important change of policy (in one respect lately) by the adoption of the rule that students shall make their choice of courses at the openings of the second term, instead of at the opening of the second year, as heretofore. The faculty have long desired to bring this about, it is said, but not until now have they seen their way to effect it. It is another evidence of the strong and natural tendency to differentiation of studies, because of the constant increase in the amount of knowledge which a student needs to master to be fairly equipped, even in one department of engineering.

The total registration at the Massachusetts Institute of Technology this year has been, up to the present time, nearly 1,100 (132 having graduated last year); 56.9% of all the students are from Massachusetts. The average age of entering is 18 years and 10 months. The number of women pursuing studies at the school is 41; 49 graduates of institutions conferring degrees are included among the students for the present year. Of these 12 are from Harvard, 3 each from Amherst, Smith and Yale, and 1 each from 22 other colleges and mechanical schools.

An example worthy of extensive imitation among engineering schools reaches us in the form of a college debate at the University of Wisconsin on the question of municipal ownership and operation of street railways, water-works and lighting plants. How many of the six students who took part in it were from the engineering school we do not know, but we have seldom seen better work by students (or any one else, for that matter) in the way of collection of facts bearing on a technico-economic question, and there could not be more useful practice for engineering students than the collection and analysis of such facts under conditions which insure prompt exposure of any serious fallacies. For the engineer who is merely a technical man and has no training in respect to the economic side of engineering questions is heavily handicapped in later life, if not in early life, and yet there is little in the regular engineering courses, and not much in his earlier years of practice as an engineering sub, to develop this side of his mind. There are ways now little used in which more training of this kind might be given than is given in connection with the regular college studies, but perhaps none more effectual or more easy to adopt than debates like the one we have referred to, which was published in the "Aegis" of March 3, 1893.

Prof. Geo. F. Swain, of the Massachusetts Institute of Technology, sends us the following note in regard to the course in irrigation lately established at Columbia College:

> I notice in your last issue a statement, in reference to some lectures on irrigation engineering now being given at Columbia College, that these lectures were said to constitute the first full course on that subject ever given at one of our large engineering schools.
>
> I beg leave to correct that statement, and to say that for a number of years students in civil engineering at this institute have had a course of lectures on irrigation engineering, as a part of the regular course in hydraulic engineering. I will not compare the length of our course with that of the one you mention, since that cannot be fairly done without knowing just what ground each course covers.
>
> Giving a thing a name of its own does not make it the first and only thing of its kind in existence.

The Massachusetts Institute of Technology has arranged with Mr. James Owen, of Newark, N. J., and Mr. E. P. North, of New York, to deliver lectures on highway engineering before the third year students in civil engineering. Both of these men are well qualified to instruct students in highway engineering from practical knowledge and experience in such work. Whether each is to deliver more than one lecture we do not know. We presume these appointments are to carry out the conditions of some special funds lately given to the M. I. T. in aid of instruction in roadbuilding, but the general policy is one worthy of imitation in all branches of engineering.

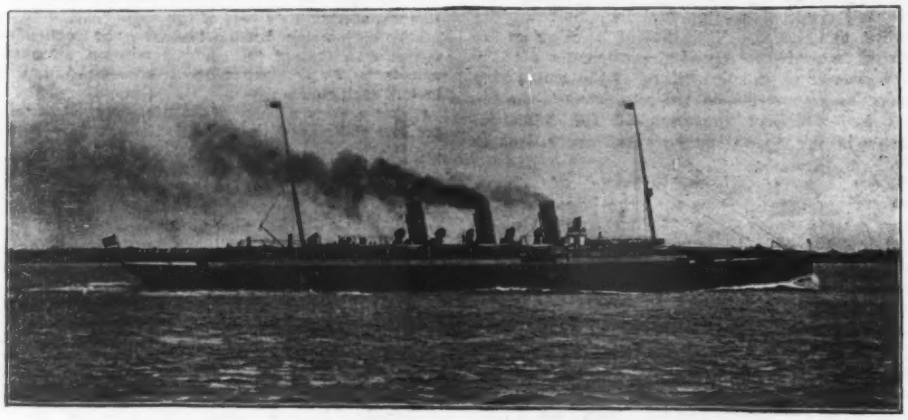
FREEZING TEST FOR BUILDING STONE.

The Russian Imperial Institute of Road Engineers, at St. Petersburg, is about to conduct an extensive series of tests to determine the resistance of various buildings stones to frost. "Kuhlow's Trade Review," of Berlin, publishes the instructions sent out to various Russian railway companies and government inspectors, substantially as follows:

> The stone samples are to be submitted to low temperatures, artificially produced, being first saturated with water. Each sample is to be submitted to the low temperature a number of times. The apparatus to be used in making the tests is to consist of a wooden box with an outside felt covering. Inside of this box are to be two other boxes, placed one within the other. The second box also is to be made of wood, with a thin sheet iron lining. Box No. 3, however, is to be made of sheet zinc. The dimensions of the several boxes are to be such that each box will have a clear space all around it of from 4 to 5 ins. The space between boxes Nos. 1 and 2 will be filled with sawdust, while the space between boxes Nos. 2 and 3 will be filled with a refrigerating mixture, to consist of three parts (by weight) of finely broken ice and one part common salt. Box No. 2 is to be made of such size that its sides will extend about 4 ins. above the sides of the inside box No. 3, and the latter is to have a cover in the shape of a fourth, closed, flat box which will virtually form also the top of box No. 2, and which also will be made of sheet zinc, and will be filled with a freezing mixture. The outside box, No. 1, is to have a wooden cover.
>
> The test samples of stone are first to be dried at a temperature of 30° C. (about 86° F.), then measured and weighed, and finally placed in water until they are thoroughly saturated. The samples are to be in the shape of a cube, with sides measuring 7 centimetres (about 2.8 ins.). Sufficient saturation of the samples is considered to have been attained after a period of from five to seven days, and its degree is to be calculated by dividing the difference between the weights of the sample after and before immersion, by the volume of the sample. Thus, if V be the volume of the cube; g', its weight when dry, and g, its weight after saturation; then the percentage of saturation with respect to volume is
>
> $$\frac{g - g'}{V} \times 100$$
>
> The sample to be saturated is, during the first 24 hours, placed in water only 2 centimetres (about 0.8 in.) deep. After that length of time it is completely submerged. The water used should be clean, and have a temperature of about 15° C. (59° to 68° F.).
>
> After saturation the samples are to be put into the freezing apparatus. After each exposure in this apparatus, the samples should be carefully examined for indications of the frost effects, such as cracks and peeling off of flakes, and a sufficient number of exposures to the low temperature should be made to finally produce such effects. Still, if after 25 exposures the sample be intact, it may be accepted as having

sufficiently demonstrated its frost-resisting powers. Samples of stones which have little or no frost-resisting power will clearly show the effects of the low temperature after from 5 to 10 exposures. The temperatures produced by the ice and salt mixture, ranging around the zero point on the Fahrenheit scale, are considered sufficiently low to admit of conclusive results as to the durability of the samples tested. The temperatures in the freezing apparatus are to be determined by placing a recording thermometer in box No. 3 together with each sample tested.

After the several exposures in the apparatus, the samples are to be further submitted to compressive tests to determine their comparative compressive strengths before and after saturation and freezing.



STEAMSHIP "FUERST-BISMARCK"; HAMBURG-AMERICAN LINE.

In order to admit of arriving at such comparative figures, it is recommended to have six test pieces of each variety of stone, three of them to be tested by compression when dry, and the other three after saturation and freezing. The compression tests can be made at the Imperial Institute, to which the test pieces and the freezing test records are to be forwarded.

THE STEAMSHIP "FUERST-BISMARCK"; HAMBURG-AMERICAN LINE.

(With inset.)

The largest of the German transatlantic steamers is the "Fuerst-Bismarck," of the Hamburg-American Packet Co., running between New York and Hamburg, and touching at Southampton.

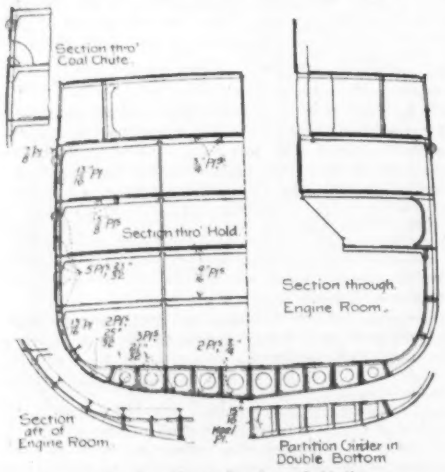

Section thro' Coal Chute.
Section thro' Hold.
Section through Engine Room.
Section aft of Engine Room.
Partition Girder in Double Bottom

Fig 1. Cross Section of Hull.

This ship was built in 1890 by the Vulcan Works, at Stettin, Germany, and is 502 ft. 6 ins. long, 57 ft. 6 ins. beam, and 38 ft. deep, with a net tonnage of 4,463 tons; gross tonnage, 8,874 tons; and displacement, 10,500 tons. The hull is built of steel, and the general method of construction is shown by the accompanying drawings, for which we are indebted to the "Zeitschrift des Vereines Deutscher Ingenieure." We are also indebted to the company for some of the particulars given below.

The ship has a vertical stem and elliptical stern. As seen by the cross-section, Fig. 1, the keel is flat, consisting of a plate 15-16 in. thick. There is a double bottom, divided into five compartments by transverse partition girders and subdivided by the central longitudinal girder which forms the keelson. The water ballast is carried in these compartments, connections being made with two of Stone's navy pumps, of 26,418 gallons' capacity per hour, for emptying any or all of the compartments. The main portion of the hull is divided into 13 compartments. There are two pole masts carrying a small amount of canvas, and three large smokestacks. The arrangement of saloons, passengers' quarters, staterooms, crew's quarters and engine and boiler rooms are clearly shown by the drawings on the inset sheet.

The ship has accommodation for 350 first cabin passengers, 120 second cabin passengers and 800 steerage passengers, or 1,270 passengers in all. The officers and crew consist of the captain, five officers, 24 engineers, 130 stokers and trimmers, and 170 sailors, stewards, physician, cooks, bakers, etc., or 330 in all, making a total of 1,600 persons on board. About 600 tons of freight can be carried in the hold, and the coal bunkers have a capacity of 2,800 tons.

The ship has twin screws, driven by a pair of triple-expansion engines of the ordinary marine type, with vertical inverted cylinders, Fig. 2, having a maximum power of 16,400 I. HP. The cylinders are 43.3, 66.93 and 106.3 ins. diameter, all of 62.99 ins. stroke. The dimensions on the drawings are given in meters. The cylinder stuffing boxes are packed with six Katzenstein metal rings and five intermediate bronze rings, with two packing rings at the bottom. The gland is fitted with a ratchet device for the simultaneous tightening or slackening of the four nuts of the stuffing box bolts. The low-pressure piston has Buckley packing rings, while the intermediate and high-pressure pistons are fitted with Ramsbottom rings. The high-pressure cylinder is furnished with a piston valve of 23.7 ins. diameter, while the intermediate and low-pressure cylinders have slide valves. The slide valve of the intermediate cylinder is balanced by the device shown in Fig. 3. The low-pressure slide valves have two ports each and are unbalanced, but are pressed against the valve seats by plates, held up by steel springs.

The air pumps are of the three-cylinder, single-expansion type, taking steam direct from the boilers and exhausting into the low-pressure steam chests of the main engines. The air cylinders are fitted with Thompson's metal valves, and are located under-

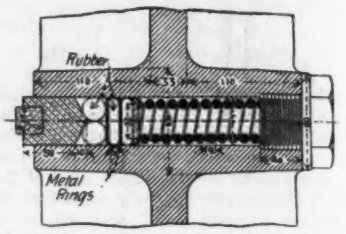


Fig. 3. Balancing Device for Intermediate Cylinder.

neath the steam cylinders. They are operated from the piston rods of the main engines. These rods are extended through the upper cylinder heads. Both pumps are so arranged that they can pump from one or both the condensers. The condensed water is pumped into two large tanks near the front of the engine room, from which it is conducted to a Weir feed water heater and to the boilers by a pair of two-cylinder feed pumps. Besides the latter, two auxiliary steam pumps and a pulsometer pump, for the purpose of furnishing water for deck washing and fire hose, are mounted in each engine room. The steam is condensed by two Weir condensers, each with a capacity of 15,860 gallons per day. For the lighting plant there

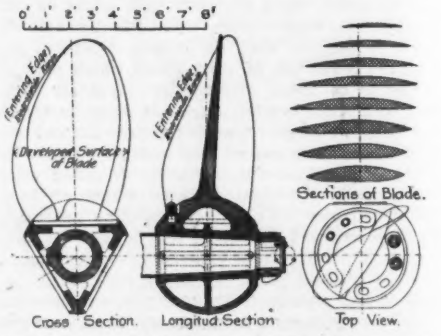


Fig. 5. Propellers of Steamship "Fuerst-Bismarck."

are four dynamos, furnishing current for about 1,000 electric lights.

There are nine double-ended boilers, arranged in three batteries. As shown by Fig. 4, each has four furnaces at each end, giving a total of 72

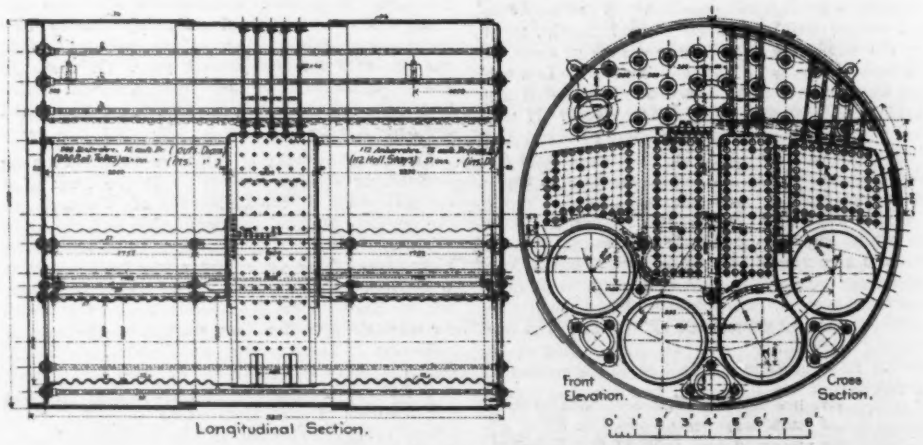


FIG. 4. BOILERS OF STEAMSHIP "FUERST-BISMARCK."

fires with 1,452.6 sq. ft. of grate area, and 46,980 sq. ft. of heating surface, or 1 sq. ft. of grate area to 32.2 sq. ft. of heating surface. No forced draft system is used, and the working boiler pressure is 156 lbs. per sq. in. The coal bunkers have a capacity of about 2,800 lbs., which, at 287 tons daily consumption, gives a steaming capacity of about ten days.

The ship is soon to be fitted with three-bladed manganese bronze propellers, but the present propellers, shown in Fig. 5, are of cast steel, 9 ft. diameter, with three blades, which are plated with tin on the front faces, and are secured to the boss of the propeller by steel set screws and bronze nuts. The blades are inclined 10° toward the rear end. The average speed of the vessel (19 knots) is effected by 14,150 HP. The speed made with the original propellers was about 19.78 knots, but since the propellers have been changed this is said to have been increased to nearly 21 knots as a maximum. The fastest run was in April, 1892, when the trip from Southampton (timed from The Needles) to Sandy Hook was made in 6 days, 11 hours, 44 minutes, which is estimated as equal to 5 days, 20 hours for

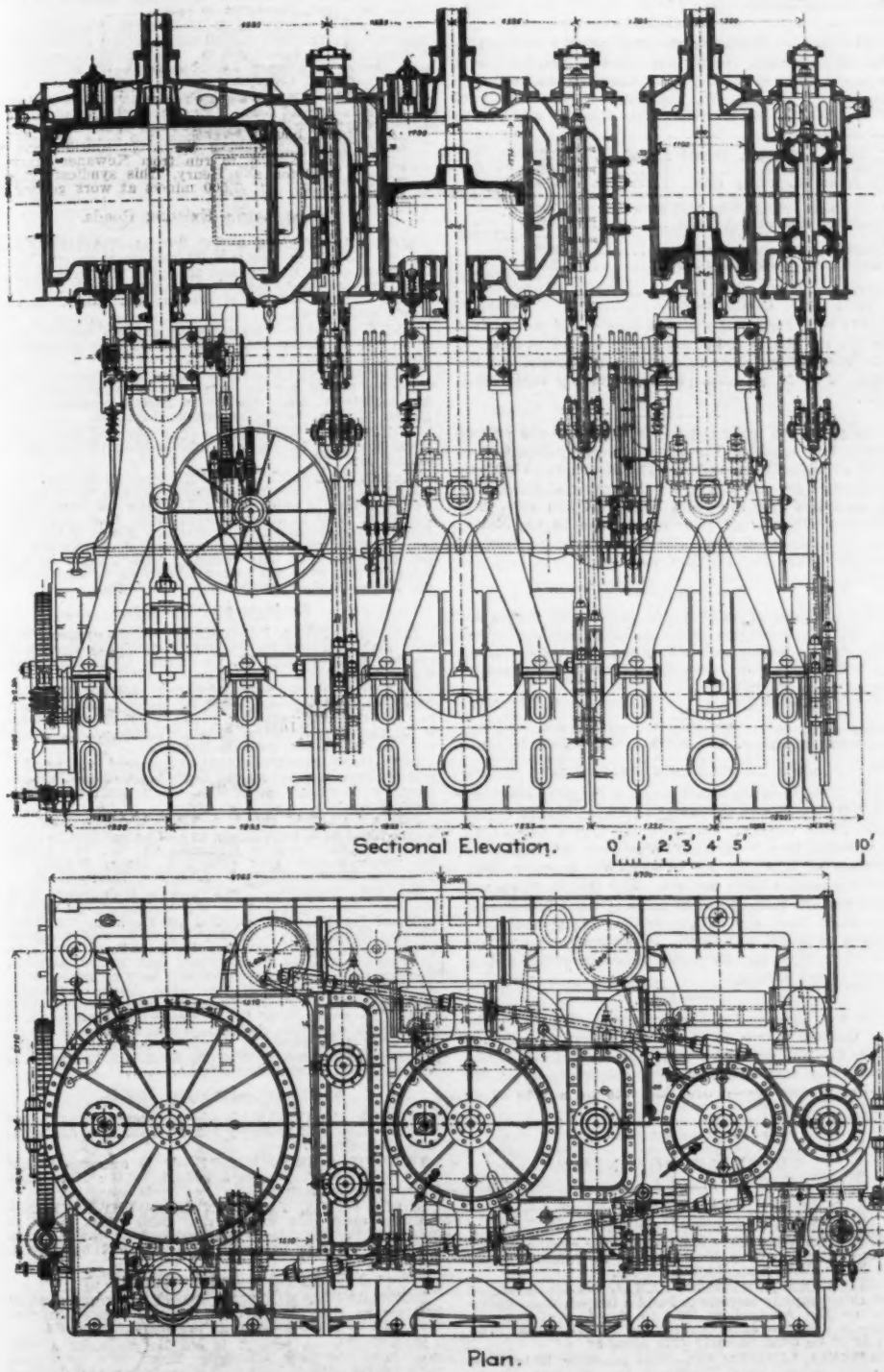


FIG. 2. ENGINES OF STEAMSHIP "FUERST-BISMARCK"; HAMBURG-AMERICAN LINE.

85 revolutions per minute. The developed area of the blades of each propeller amounts to 86.11 sq. ft., while the projected area is 86.11 ft.; therefore, each square inch of the propeller faces is subjected to an average thrust of about 13 lbs.; as an average 14,150 HP. effective work of the engines is required to produce the speed of 19 knots.

In the trial trip, in which a distance of about 30 miles was run over twice, the "Fuerst-Bismarck" made 20.7 knots; the highest effective power developed with natural draft was 16,412 I. HP.—a very favorable showing. The daily consumption of coal amounts to 287 tons for producing an average of the run from Queenstown to Sandy Hook, which is the one on which the record breaking trips are made.

MATTER HELD IN SUSPENSION IN MOVING WATER.

In a late issue of "Le Genie Civil," M. Gallois describes an easy experiment for demonstrating the action of solids held in suspension in moving water.

He says, take a bottle of white glass, about 3 ins. in diameter and with a flat bottom; put into it, to the depth of about 2-10 in., some fine and very clean silicious sand, that will not interfere with the transparency of the water, with which the bottle is then to be filled. Cork it in such a manner as to exclude all air. Then give the bottle a rapid movement of rotation around its own axis, either by placing it on a turn-table, or by suspending it from a previously well twisted cord.

It will then follow that all the sand will be projected upon the cylindrical sides of the bottle by centrifugal force. The rotation movement of the bottle will gradually communicate itself to the water, progressing from the sides to the axis, and as long as rotation lasts the sand will adhere to the cylinder. As soon as the water turns with the same velocity as the bottle containing it, suddenly stop the bottle. The sand will at once quit the sides and precipitate itself towards the center of the bottle in the form of a cloud, and it will then reassemble its particles on the bottom in the form of a cone, having the same axis as the bottle, and being higher as the velocity of rotation is greater. Finally, the cone flattens as the velocity of rotation grows less, until the slope of the conical surface is the slope of equilibrium of grains of sand in still water.

The explanation of these phenomena is very simple. When the movement of rotation of the bottle is stopped, the water, by reason of its inertia, continues to turn; but the friction against the sides of the bottle tends to decrease the velocity of movement, and this decrease progresses successively from the sides to the center, in such manner that the relative velocity of the liquid threads is greater at the axis or center of the bottle. The sand is pushed toward the center by a force which is proportional to the velocity of the fluid. As this velocity decreases, the force of impulse toward the center decreases, and the cone flattens out, until it assumes the shape due to still water.

RAILWAY CONVENTION IN INDIA.

A convention of executive officers of Indian railways is to be held in the autumn of the present year and rules have been formulated for the presentation and discussion of various subjects. The voting power of each delegate will be determined by the importance of the railway represented by him. At the conference of 1888, the open mileage regulated the voting power of each line, and it is not

clear what other quality will denote the importance in the present instance. The "Indian Engineer" thinks that the tonnage of traffic carried would be the soundest principle to work upon.

The following are among the subjects to be presented:

The modification of general rules of 1892 for working state railways, to render them suitable for general adoption.

Revision of general rules for railways under construction.

Procedure to be pursued in the diversion of passengers, parcels, baggage and freight during the interruption of through direct communication, and the subsequent adjustment of fares and freight.

The detention of damaged rolling stock on a foreign line.

The equalization of rolling stock, and the acceptance of open freight cars with proper sheets and ropes.

Establishment of a claims committee.

Commission for collection of freight charges due to foreign lines.

Transhipment of perishable goods received in open cars to be performed at the expense of the forwarding railway.

Liabilities of railways to each other for transfer of passenger's baggage at junctions.

Division of through rates to and from stations on branch lines.

Uniformity of traffic statistics, and the practical utility of these statistics in their present form.

Reduction of lowest class fares.

Adoption of a monthly system of station accounts.

Traveling on Indian railways.

Proposed subsidiary rule for a train approaching a station where only one signal is alight.

Gross load per axle and per running foot to be carried by meter-gage cars.

The franchise for the East River bridge was granted by the New York Board of Aldermen on March 21. The company proposes to build two suspension bridges, with railway tracks, roadways, and footwalks. The north bridge will have a span of 1,670 ft., and be 3,200 ft. long between anchorages. The south bridge will be 1,470 ft. span and 2,700 ft. between anchorages.

The new lighthouse which is to be constructed at Cape la Heve, near Havre, France, will contain lights of an aggregate of 19,750,000 c. p., exceeding the candle power of any similar structure, according to "Neuzeit." It is claimed that in fair weather the lights will be visible at a distance of 312 miles, while they will be discernible in foggy weather 137 miles off. The lantern is to be square, and will revolve three times a minute, in a groove filled with oil, in order to diminish friction.

According to the "Journal fuer Gasbeleuchtung und Wasserversorgung," the production of naphtha in the Baku district, at the Caspian Sea, amounted to 4,749,000 tons in 1891. This amount was disposed of as follows:

Exported	161,357	tons
Utilized as fuel	307,317	"
Shipped to inland (Russian) factories	4,154,358	"
Stored within the district	125,468	"
Total	4,749,468	tons

Recently a well has been sunk in this district which, it is claimed, has an average flow of 8,000 tons of naphtha in 24 hours.

A pump operated by an electric motor has been installed in the Fireman's Insurance Building, Baltimore, Md., by D. E. Evans & Co., of that city, to run an Otis hydraulic passenger elevator formerly run by city water. The plant consists of a 15-HP. Thomson-Houston motor belted to an 8×8-in. triplex pump, furnished by the Goulds Mfg. Co., which maintains a pressure of 80 lbs. in a pressure tank of 1,500 gallons capacity. The control of the motor and pump is effected by a Clark regulator furnished by the Thomson-Houston Co. The pump is speeded at 40 revolutions per minute, and maintains a uniform pressure of 80 lbs. in pressure tank. The regulator is so adjusted that upon the starting of the elevator the pump and motor will start within a variation of a few pounds from the normal pressure, and upon completion of the elevator trip the pressure is again accumulated and the pump and motor automatically stopped and no current used. From the data collected regarding the power consumption, etc., it is calculated that the power for ten hours a day for a month would not exceed five to six horsepower, which is a very economical rate for operating an electric elevator for office buildings. The apparatus is so arranged that in case of a breakdown at the electric power station, the city water can be instantly turned on, and the elevator run by its pressure until the electric energy is again supplied. In the Oregonian Building, Portland, Ore., one 10×12-in. triplex power pump operates two large passenger elevators, two sidewalk lifts and one freight elevator. The pump discharges into a 3,000-gallon pressure tank, maintaining a uniform pressure of 100 lbs. per sq. in. The motive power, is a 75-HP. Edison motor, which, in addition to running the pump, operates a large Hoe printing press and other machinery connected with the printing outfit. The discharge to a pressure tank is automatically regulated by means of a by-pass valve, which is made to shift the water from pressure tank to open tank as the pressure reaches its normal amount.

The cost of extending the water-works intake tunnel at Cleveland, O., for 2½ miles in the form of a masonry lined tunnel 8⅔ ft. in diameter has been estimated by Mr. M. W. Kingsley, Superintendent of Water-Works, at $810,600. The detailed estimate is as follows:

13,200 ft. of 8⅔-ft. tunnel at $37	$488,400	
Temporary crib	62,000	
Shaft at temporary crib	15,000	
		$565,400
Permanent crib at lake end, of wood	195,000	
Shaft at crib at lake end	15,000	
		$210,000
Removing temporary crib	8,000	
Connecting with old tunnel	2,600	
		$10,600
Contingency, etc	14,000	
Total with contingency		$810,600

It is estimated that a year's time would be required to sink the shafts and protect them by means of cribs, and 440 working days to complete the tunnel, on the basis of 30 ft. progress per day, working three headings.

Steel ties are being ordered in Germany—the present low prices inducing the state railway authorities to give out some large orders. The Baden state railway authorities are contracting for the supply of 24,600 tons of steel ties over the years 1893, 1894 and 1895. The Prussian Minister of Railways is also in negotiation for the supply of large quantities of steel sleepers, offering $24.75 per metrical ton, but the makers ask $25.75.

The earnings of railways in the United States for the month of January were decidedly unsatisfactory, according to figures collected by the "Financial Chronicle." The following shows the results of operations reported from 125 railways:

	1893.	1892.	Incr. or dec., p. c.
Gross earnings	$55,860,995	$55,100,108	+1.38
Operating expenses	42,499,739	40,417,853	+5.15
Net earnings	$13,361,256	$14,682,255	—9.00

The table shows a small increase in gross earnings, but the increase in operating expenses, owing to the unfavorable weather, was so great that a loss of 9% is recorded in net earnings. Moreover, this follows a decrease of 6.15% in net earnings for January, 1892. The decrease is quite general. Only the Southern and Southwestern railways show gains of much importance. The trunk lines and anthracite coal roads exhibit decreases of 29.3% and 34.3%, respectively. Out of the 125 roads reporting, 39 report losses in gross, and 59 losses in net earnings.

The new Chicago building ordinance adopted by the City Council, March 13, limits the height of buildings to 130 ft. The ordinance was vetoed by Mayor Washburne, who wished the limit of height placed at 160 ft., but it was passed over his veto by a veto of 49 to 2.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

GEORGES VALLEY.—Work is making rapid progress on the extension from West Warren to Union, 8 miles. Ch. Engr., Wm. Lee, Bucksport, Me.

DELAWARE & HUDSON CANAL CO.—It is stated that this company intends to build a branch from Riverside, on the Adirondack Ry., to the foot of Schroon Lake, a distance of about ten or twelve miles. The line is to be finished early this summer.

CAMBRIA LUMBER CO.—This company is building a logging railway from Foustwell, Pa., up Shade Creek, a distance of about ten miles. About five miles are now graded and tracklaying is in progress.

MIDDLESEX VALLEY.—It is stated that a bonus of $10,000 has been raised to aid in the construction of an extension from Stanley to Geneva, N. Y.

TOLEDO, COLUMBUS & CINCINNATI.—It is stated that the contracts have been let for the proposed extension from Ridgeway, O., to Marysville, O.

PITTSBURG, FT. WAYNE & CHICAGO.—The Pennsylvania Co. has just authorized the expenditure of $600,000 to be used in continuing the second track and other improvements on this line between Allegheny City, Pa., and Crestline, O. The new second track will be between Massillon and Orrville, O., and Londonville and Mansfield, O. The contracts have been let and it is expected to have the work completed by Oct. 1.

WESTERN NEW YORK & PENNSYLVANIA.—This company is replacing its wooden bridge at Titusville, Pa., with a new iron structure. Eleven other bridges, all of steel, will be built by this road during the coming summer, at an average cost of $10,000 each.

Projects and Surveys.

CUMBERLAND.—This company has been organized to build a railway from Cumberland, Md., to Moorefield, W. Va. Pres., C. Wood Daily, Cumberland, Md.

INDIANAPOLIS, BLOOMINGTON & BEDFORD.—Chartered in Indiana to build a railway from Indianapolis to Bedford, Ind.

DETROIT & TOLEDO SHORT LINE.—Surveys are reported in progress for a railway from Toledo, O., to Detroit, Mich.

COLUMBUS CENTRAL.—A railway company by this name has been chartered in Ohio.

CHICAGO, INDIANA & EASTERN.—This company has been incorporated in Indiana to build a railway from Chicago, Ill., to Columbus, O. Among the incorporators are: Henry A. Thayer, Lester J. Barr, W. W. Paddock and others, of Chicago.

ILLINOIS.—A press dispatch says: "A new railway is being talked of from Kewanee, and a syndicate of Chicago and Kewanee capitalists are in the deal. They have already bought several thousand acres of land in Stark County, containing the rich coalfields, and are talking of a railway to run from Kewanee eastward through Castleton and Henry. This syndicate expects to put from 1,000 to 1,500 miners at work getting out coal."

Southern.—Existing Roads.

MIDDLE GEORGIA & ATLANTIC.—Tracklaying began on the 25-mile line from Machen to Covington, Ga., on March 13. This line was graded in 1891 and all that now remains to be done is to lay the track and construct about 1,900 ft. of trestle. Ch. Engr., Arthur Pew, Machen, Ga.

UNION RY. CO.—This company expects soon to complete the remining two miles of its belt railway at Memphis, Tenn.

BEAVER CREEK.—It is stated that surveys will soon be begun for an extension of this railway to Moorefield, W. Va. The line is now in operation from Davis, W. Va., to Stoney Brook, 15 miles.

NORFOLK & WESTERN.—It is reported that a contract has been let for a 13-mile branch to the foot of Clinch Mt., Va.

NASHVILLE & KNOXVILLE.—Grading is about completed on the line from Allgood Station to Standing Stone, Tenn., 12 miles, and tracklaying will begin about April 10. The locating surveys have been begun for the further extension from Standing Stone to the Cincinnati Southern Ry., 40 miles, and contracts will be let about May 1. The company also intends to construct a line from six to ten miles long to coal banks. Ch. Engr., R. J. Moscrip, Cookeville, Tenn.

Projects and Surveys.

RONCEVERTE & LEWISBURG.—This company will soon make surveys for its proposed railway from Ronceverte to Lewisburg, W. Va. Pres., Chas. D. Haines, Kinderhook, N. Y.

RICHMOND, MANCHESTER & MIDDLEBURG.—This company has completed its organization by electing the following officers: Pres., G. E. Fisher; Secy., F. J. Craigie; Directors, Chas. Watkins, A. L. Adamson, W. W. Baker, John E. Taylor.

POTOMAC SHORT LINE.—Chartered to build a railway from a point on the south bank of the Potomac River in Morgan Co., W. Va., to a point near Hancock, Md.

INDIAN CREEK COAL & TRANSPORTATION CO.—Chartered in West Virginia to build a railway 15 miles long up Indian Creek in Kanawha Co., W. Va. Among the incorporators are: Chas. J. Hunt, Walker L. Granger, Cincinnati, O., P. J. Zuney, Hartwell, O.

NORTH CAROLINA.—The Durham & Charlotte R. R. Co. has been chartered by the legislature to build a railroad through the counties of Durham, Chatham, Moore, Montgomery, Stanly, Cabarrus and Mecklenburg. The company will buy out a railway, ten miles of which is graded in Chatham and Moore counties. The total length of the road will be 130 miles. Wm. A. Guthrie, Durham, N. C.—The Neuse & Swansboro R. R. Co. will shortly be organized in New York city. The road awill be 30 miles in length. It is planned to run from Swansboro and connect at Riverdale with the Atlantic & North Carolina R. R.—The Columbia, Charlotte & Winston R. R. Co. has received its charter from the legislature.

Northwest.—Existing Roads.

WISCONSIN CENTRAL.—Local papers state that this company will probably build a spur into Appleton, Wis., this season.

DULUTH & IRON RANGE.—It is announced that work will soon begin on a branch to the Hale mine in the Mesaba Range.

SIOUX FALLS, YANKTON & SOUTHWESTERN.—Grading upon this 60-mile line from Sioux Falls to Yankton, S. Dak., has been resumed at the Yankton end. The road is expected to be finished by July 1, 1893.

Projects and Surveys.

HIGHLAND & MINERAL POINT.—A correspondent informs us that the surveys for this Wisconsin railway will be made as soon as the weather permits.

MANITOBA.—A project is on foot to build a railway southeast from Winnipeg, Man., to a connection with Duluth, Minn., and it is stated that $8,000,000 of New York capital has been secured to build the line. The intention, as stated, is to run from Winnipeg, south of the Canadian Pacific, tapping the Rainy River country and through to Port Arthur, a distance of between 400 and 500 miles. It is proposed to utilize the Manitoba Southeastern or Winnipeg Southeastern charters through the province to the Lake of the Woods, and also utilize the charter of a company which has powers to run through the Rainy River country until Port Arthur and Duluth are reached. The new company has made arrangements for running over the latter line to Port Arthur. The connection with the Port Arthur, Duluth & Western Ry. will shortly be completed to Zenith City, and running power will be secured over this line for the entire length of the system. The company asks the government for a cash bonus of $450,000 on 110 miles—a rate of $4,000 per mile. It does not ask for the payment of this amount until after the completion of the line, in 1895.

Southwest.—Existing Roads.

AUSTIN & NORTHWESTERN.—The bonus of $40,000, right of way and depot grounds, for the extension

from Burinet to Lampasas, Tex., have practically been secured, and it is stated that locating surveys will begin soon.

Projects and Surveys.

PINE BLUFF & SULPHUR SPRINGS.—Pres. R. D. Davison, Pine Bluff, Ark., writes us that the surveys have been completed for this railway from Pine Bluff to Sulphur Springs, Ark., seven miles, and that the right of way has been obtained and a stock subscription of $15,000 secured. Ch. Engr., J. J. Martin; Secy. and Treas., J. H. Humphry.

BOLIVAR & KANSAS CITY.—This company is to be chartered in Missouri to build a railway from Bolivar, Mo., to a point on the Kansas City, Clinton & Springfield R. R., between Aldrich and Humansville, Mo. R. B. Vilas, H. B. Donnegan and others are interested.

Rocky Mountain and Pacific.—Existing Roads.

COLORADO MIDLAND.—Work has been discontinued on the branch to Cripple Creek owing to the severe weather.

Projects and Surveys.

ASPEN & MAROON.—Ch. Engr. C. E. Shriver, Aspen, Colo., has completed the preliminary surveys and estimates for this line from Aspen to the head of Maroon Creek, Colo., 15 miles. Pres., J. E. Freeman, Aspen, Colo.

Foreign.

MONTEREY & MEXICAN GULF.—Construction began March 14 on the extension from Trevino toward Sierra Mojada, Mex.

BOGOTA & MAGDALENA.—This company has filed articles of incorporation with the Secretary of State of Colorado for the purpose of purchasing and operating the Girardot Ry. in the Department of Cundinamarca, Colombia, by concession from the government to John H. Pennington. The stockholders are principally capitalists of Pittsburg, Indianapolis, New York, Philadelphia and Bogota. It is proposed to build three lines of railroad, about 300 miles in all, from Bogota to points on the Magdalena River. The principal offices will be in Pittsburg, but the company has branch offices in Denver.

COATEPEC.—A syndicate of Mexican and English capitalists have purchased the Coatepec Ry., and announce that they will immediately begin the work of extending it to the different points. One extension is to be built to Pacho Nueva, a station on the Mexican Inter-Oceanic Ry. The rich coffee districts of Teocolo, Jico Huatusco and Cocautlan are also to be penetrated by the proposed system.

BRIDGES, TUNNELS ADD CANALS.

MANCHESTER, N. H.—Bids will be received until March 28 for a highway bridge across the Piscataquog River. The structure, it is reported, will cost $50,000.

HOLYOKE, MASS.—A highway bridge 950 ft. long is to be built across the Connecticut River by Watson Whittlesey. The Berlin Bridge Co., East Berlin, Conn., has prepared plans.

WAYNESBORO, VA.—Bids are wanted for two iron bridges. John Paul, Fisherville, Va.

MONTGOMERY, ALA.—The Montgomery Brewing Co., will build a bridge over the Alabama River. Bids will probably be received by May 1. Sec., C. E. Hails.

PAISLEY, ONT.—Bids will be received until March 30 for a 200-ft. span highway bridge. S. McArton, Reeve.

NIOBRARA, NEB.—The large bridge across the Niobrara River, recently washed away, will be replaced.

STEELTON, PA.—It is stated that arrangements are well advanced for forming a company to build a bridge across the Susquehanna River, connecting this place with New Cumberland.

BROOKLYN, O.—The bill before the Ohio legislature authorizing the issue of $160,000 of bonds to build a bridge over Big Creek, connecting this place with Brighton, O., is a law.

ELECTRIC RAILWAYS.

FITCHBURG, MASS.—The Fitchburg & Leominster St. Ry. Co. proposes to extend electric propulsion to its entire system.

JERSEY CITY, N. J.—E. F. C. Young, of Jersey City; Jeremiah O'Rourke, of Newark, and Bernard Naughton have formed a corporation to be known as the Consolidated Traction Co., with an authorized capital stock of $15,000,000. The purpose is to consolidate the traction companies of Jersey City, build branches to Newark, and to other surrounding towns, and in general to make large extensions to the present street railway systems of Jersey City.

GOSHEN, IND.—A franchise has been granted to the Indiana Electric Power Co. to construct a street railway.

APPLETON, WIS.—Surveys have been made for the extension of the electric street railway to Melnasha and Kaukanna.

WAUWATOSA, WIS.—Chartered, Wauwatosa St. Ry. Co.; capital stock, $25,000.

MT. VERNON, O.—The Mt. Vernon Electric Light & St. Ry. Co., to build 8½ miles of street railway.

CHICAGO, ILL.—Chartered, Chicago, Niles & Norwood Rapid Transit Co.; Chicago to Niles; capital stock, $500,000.

WICHITA, KAN.—Chartered, Wichita Electric Ry. & Light Co.; capital stock, $450,000.

SAN ANTONIO, TEX.—Chartered, Citizens' Electric Power & Street Ry. Co.; capital stock, $600,000.

WILMINGTON, DEL.—Organized, Peninsula Electric Ry. Co.; Milton to Wilmington; capital stock, $900,000.

PHILADELPHIA, PA.—Chartered, Chestnut Hill & Norristown R. R. Co.; Chestnut Hill to Norristown; capital stock, $48,000. Pres., Wm. H. Heuling, Haddenfield, N. J.

HORSE AND MOTOR RAILWAYS.

MEADVILLE, PA.—Chartered, Cambridge & Edinboro St. Ry. Co.; capital stock, $50,000; Pres., Geo. D. Frawin.

HIGHWAYS.

NEW YORK.—The commissioners appointed to determine upon the necessity of a new highway to connect the Oceanville and Hempstead road with the East Rockaway and Washington Square road, in Queens county, have decided that the road is necessary.—Bids will be received until April 12 for repairing about 11,000 lin. ft. of the macadamized highway known as the Jericho turnpike, in Queens county; also for about 1,350 cu. yds. of traprock, macadam stone and screenings. Robt. Seabury, Clk. of Bd. Long Island city. See advertisements.

OHIO.—The commissioners of Muskingum county are preparing to pave four miles of the river road south from Zanesville with vitrified brick, one half of the cost to be paid by private subscription and the other half to come from the township and county.

WASHINGTON.—The house committee on roads has favorably reported on a bill to appropriate $20,000 toward the construction of a road from Whatcom county via the North Fork of the Nooksack to the Ruby Creek and Okanogan mines.

WATER-WORKS.

New England.

BAR HARBOR, ME.—The legislature has passed an act which virtually requires the Bar Harbor Water Co. to extend its works or to submit to competition from the Eden Water Co. The latter company has no power to build works unless the former fails to make the extensions.

CHICOPEE, MASS.—The laying of 8,000 ft. of 12-in. pipe is proposed. It is stated that most of the pipe is on hand.

WEST BOYLSTON, MASS.—Application has been made to the legislature by the town through Sheehan & Cutting, Attys., for permission to introduce a gravity water supply from brooks in the town of Holden.

NIANTIC, CONN.—Steps have been taken to secure and build works. The proposed supply is said to be Sturtevant's upper reservoir.

Middle.

FORT EDWARD, N. Y.—We are informed that the contract for works has been awarded to Hallinan Bros. and C. D. Fenton, Little Falls, the lowest bidders, for $86,587. The other bids were: Troy Public Works Co., $87,777; A. H. Coon & Sons, Kingston, Pa., $88,004; Flood & Sherrill, Sandy Hill, $89,178; M. B. Birdseye, Fayetteville, $93,190; Drake & Stratton, Sandy Hill, $105,758; Moffett, Hodgkins & Clarke Co., New York city, $110,835. S. E. Babcock, Consult. Engr., Little Falls.

GLOVERSVILLE, N. Y.—The Kingsboro Water-Works Co., which supplies the northern section of the town, has voted to increase its supply and make other improvements. E. L. Heacock, Secy.

MEDINA, N. Y.—The plant of the Medina Water-Works Co. has been tested and accepted. Geo. B. Bassett, Buffalo, was expert for the city during the test.

MOUNT KISCO, N. Y.—The village will try to secure authority to build works.

NEW YORK, N. Y.—Bids are wanted until April 20 for furnishing materials, building and erecting pumping engines, boilers and appurtenances for the high service works at the new aqueduct, between Tenth Ave. and Harlem River. M. T. Daly, Comr. Pub. Wks.

PLEASANTVILLE, N. J.—An artesian well is being bored to supply the town.

WESTFIELD, N. J.—The recent election went in favor of contracting for a supply from the Union Water Co., whose interests are the same as those of the company supplying Plainfield.

HOLLIDAYSBURGH, PA.—The Bell Water Co. has been incorporated; $20,000; Treas., Clara Bell; Directors, John Dean, R. M. Christy and Martin Bell. The present works are owned by the borough.

MOUNT HOLLY, PA.—Engr. S. M. Hepburn, Carlisle, will make surveys for gravity works.

POTTSVILLE, PA.—It is reported that the company will build its reservoir above St. Clair, which failed last June.

CUMBERLAND, MD.—Plans for a new supply will be made by Engr. Milner P. Paret, Baltimore.

Southern.

MARTINSVILLE, VA.—J. E. M. Hanckel, Vice-Pres. Virginia Paving and Construction Co., informs us that his company has the contract for works; price, $24,000, in 6% bonds.

BARNESVILLE, GA.—Engr. N. Wilson Davis informs us that the following bids for constructing works were received: Cooke & Reade, Cincinnati, $17,980; P. O. Hebert, Chattanooga, $18,990; Stilwell-Bierce & Smith-Vaile Co., Dayton, O., $19,036; Howard Neeley, Athens, Ga., $20,700; T. Wm. Harris, 44 Broadway, New York city, $21,358; Westbrook & Burr, Griffin, Ga., $22,036; J. C. Chase, Wilmington, N. C., $24,785; Moffett, Hodgkins & Clarke Co., New York city, $25,-. Hebert, Chattanooga, $18,990; Stilwell-Bierce and Smith-Vaile Co. for the plant complete with no margin for extras.

BREWTON, ALA.—It is reported that water and electric lighting plants will be built at once by John Turner, Mobile, under a franchise already granted.

EVERGREEN, ALA.—Works are projected.

CHATTANOOGA, TENN.—The Chattanooga Co., Ltd., proposes to build works for its own supply and that of "Hill City;" estimated cost, $50,000. Water will be taken from springs, it is said.

PARIS, TENN.—A vote will be taken on issuing $35,000 of bonds for water, and $10,000 for electric lighting plants.

North Central.

CLEVELAND, O.—Bids are wanted until April 12 for about 450 48 to 4-in. gates; also for constructing a temporary wooden crib for the proposed intake tunnel extension, the city to furnish the lumber. R. R. Herrick, Dir. Pub. Wks.

NORWOOD, O.—Bids will probably be wanted at once for $25,000 of 5% bonds for works.

READING, O.—Bids are wanted until March 28 for three 8-in. deep-well pumps, with steam ends, in place; also until April 12 for about 300 tons 3 to 10-in. coated cast iron pipe, 6 tons specials, 50 hydrants and 30 valves, with stop boxes, and for laying the pipe, etc. A. G. Aukenbauer, Clk. Bd. W.-Wks. and Elec. Lt. Trustees.

EVANSVILLE, IND.—The water-works department is to correspond with engineers regarding proposed new works.

HUNTINGBURG, IND.—The Huntingburg Water Co. has been incorporated; $25,000; W. R. McMahon, Adam Stratman and others, Huntingburg.

OXFORD, IND.—Small water and electric light plants are discussed.

FAIRBURY, ILL.—A contract for an extension of the works has been awarded to Chas. T. Tobin, Hillsboro. The cost of the extension and an artesian well will be about $20,000.

DELAVAN, WIS.—The people have voted $20,000 of bonds for works, 9 to 1.

KAUKAUNA, WIS.—Bids for works on the franchise plan, including 8¾ miles of mains and 85 hydrants have been received as follows, on the basis of annual rental and price for additional hydrants; W. G. Maxcy, Oshkosh, $6,175 and $60; C. E. Gray, Whitewater, $6,000 and $65; Moffett, Hodgkins & Clarke Co., New York city, $5,600 and $50, the city to pay 6% interest on the cost of a secondary supply if it requires one. G. C. Morgan, Chicago, offered to put in the works, with ten miles of mains, and sell them to the city for $76,500; $25,500 to be paid on completion of the works and $50,000 in bonds.

Northwestern.

ELDON, IA.—The people have voted for works.

UNION, IA.—A vote on works is talked of.

WASHINGTON, KAN.—The following bids for building works have been received: Thos. L. Rosser, Jr., Minneapolis, $34,366; Pomerene & Cooper, Lincoln, Neb., $32,875; Zeigler & Dalton, Junction City, Kan., $32,500; A. F. Paige Co., Sioux City, Ia., $31,875; E. A. Rudiger, Nebraska City, Neb., $30,645; Edmund T. Sykes, Minneapolis, Minn., $27,895.

Southwestern.

MARYVILLE, MO.—The pipe which recently failed here is to be replaced by an elevated and enclosed tank, 18½ x 50 ft., with its bottom at an elevation of 85 ft. The tower will be of masonry.

LAREDO, TEX.—Bids for the water tower designed by Edw. Flad, Consult. Engr., St. Louis, Mo., were as follows: Tippett & Wood, Phillipsburg, N. J., $9,928; Smith, Peden & Co., $9,260; Wisconsin Bridge & Iron Co., Milwaukee, $8,850; San Antonio Foundry Co., $7,870; Scherpe Iron Works, $7,300. The contract was awarded to the Scherpe Iron Works.

NORMAN, OKLA.—It is reported that water and electric lighting plants will soon be put in.

WICHITA FALLS, TEX.—It is reported that bids for works are being received. Cann & Lynch, Engr.

RIDGWAY, COLO.—The Ridgeway Water Co. has been incorporated; $50,000; C. H. Nix, Otto Mears, Fred. Walsen.

Pacific.

HOQUIAM, WASH.—Bonds to the amount of $45,000 are proposed by the council for works, with a 4½-mile supply pipe from the headwaters of the Hoquiam River.

MOUNT VERNON, WASH.—Works are again projected.

PALOUSE, WASH.—A contract for a stand-pipe has been awarded to the Stearns Mfg. Co., through their Chicago office; D. J. Lewis, Mech. Engr. Mr. Lewis will make plans for the pipe and foundations.

LINDSAY, CAL.—The Lindsay Water Development Co. has been incorporated; $25,440.

SOUTH RIVERSIDE, CAL.—The Rugby Water Co. has been incorporated; $28,000.

SPANISH FORK, UTAH.—Works are projected.

IRRIGATION.

SAN DIEGO, CAL.—The contract for laying 70 miles of mains and laterals has been awarded by the Linda Vista Irrigation District to Wade & Cooper, for $211,130.

WOODVILLE, CAL.—A contract for constructing canals in this district has been awarded to Barris, Haden & Neill, at 8½ cts. per cu. yd. in smooth ground and 13 cts. in rough or rocky soil. It is said that the main canal will be 22 miles long, and one of the longer branches 16 miles. It is estimated that there will be 400,000 cu. yds. of earth to be removed.

NEW COMPANIES.—Albuquerque (N. M.) Irrigation Canal & Improvement Co.; $500,000. La Luz (N. M.) Irrigation & Improvement Co.; $45,000. Watson Ditch Co., Visalia, Cal.; $54,000. Evans Ditch Co., Visalia, Cal.; $72,000; J. B. O'Connor, J. B. Smith.

SEWERS.

CAMDEN, ME.—At the annual town meeting March 20 it was decided to construct a sewer 1,450 ft. long from Elm St. to tidewater.

BROCKTON, MASS.—The report of the sewerage commissioners, referred to in our issue of March 2, has been adopted, and a sewerage loan of $285,000 authorized, at 4% interest, for 30 years.

FITCHBURG, MASS.—The highway committee has been ordered to prepare plans for the abolition of the Punch Brook district nuisance. Sewers for this district are estimated to cost $10,000.

NEWTON, MASS.—Plans for the surface drainage of the city have been prepared by Albert T. Noyes and Edward A. Buss, civil engineers. The scheme provides, in connection with the improvement of natural water courses, the carrying out of a boulevard and small park system. The water courses are to be deepened and straightened, and made to dispose of the entire surface drainage.

PITTSFIELD, MASS.—The council has voted $60,000 for sewers to be constructed this coming summer.

PAWTUCKET, R. I.—The city treasurer will sell, March 25, $800,000 of 4% bonds, of which $400,000 is a sewer loan.

NEW BRITAIN, CONN.—The sewer commissioners have recommended the construction of a sewer in the southern portion of the city, to cost $70,000.

SOUTHINGTON, CONN.—A petition for a sewerage system will soon be presented to the borough officers.

HERKIMER, N. Y.—The state board of health has approved the plans for a system of sewerage for this village.

MOORESTOWN, N. J.—The taxpayers have passed a resolution in favor of issuing bonds for a system of sewers.

HARRISBURG, PA.—The following bids were received for a sewer 2,500 ft. in length in Muench St.;

Ward & Stucker, $15,550; Flannigan Mathew, $15,830; P. H. Vaughn, $17,500; H. Opperman, $18,570; James Nolen, $19,521.

BALTIMORE, MD.—Sewer ordinances appropriating $118,100 have been favorably reported by the committee on sewers.

BRUNSWICK, GA.—Plans for a sewerage system are being prepared by Frank Hartford.

CLEVELAND, O.—The direction of public works will receive bids until March 29 for sewers in seven streets, and until April 12 for sewers in five streets.

COLUMBUS, O.—The board of public works has voted in favor of constructing a main sewer in Blumenthal's addition, to cost $61,518.

DETROIT, MICH.—The board of public works has recommended that sewer bonds be issued for $250,000.

MILWAUKEE, WIS.—The board of public works has recommended that pipe sewers be constructed in ten streets.

WAUWATOSA, WIS.—A bill is to be presented to the legislature providing for a system of sewerage, and also for the relief of the Menomonee and Kinnickinnic rivers.

MENASHA, WIS.—A sewer is to be constructed from Lake Winnebago to Lake Butte des Mortes. The length will be about a mile and cost about $12,000.

LE MARS, IA.—We are informed by J. K. Bowman, Cy. Engr., that plans have been adopted for a sewerage system, to cost about $73,000, of which it is thought about $20,000 will be expended this spring.

OKLAHOMA CITY, OKLA.—J. A. Courtney, Cy. Engr., informs us that the following sewers are proposed: 20-in. main, 4,000 lin. ft., average cut 11 ft., and 1,500 lin. ft., average cut 5 ft.; 8-in. laterals, 8,300 lin. ft., average cut 7 ft. Sewer bonds for $17,500 have been voted, as noted in our issue of March 9.

GLENWOOD SPRINGS, COLO.—The council has passed an ordinance providing for the construction of a sewerage system. The work will be advertised, and the contract awarded to the lowest bidder. A. W. Dennis, Mayor.

LOS ANGELES, CAL.—The city engineer has been directed to prepare plans and specifications for a system of storm-water drains in conformity with the report of the board of engineers, made in 1889. Ex-City Engineer Eaton reported that at least $500,000 would be necessary for an immediate system adequate to carry off the water, and that $1,000,000 distributed over about ten years' time would put the city in first class drainage condition.

OAKLAND, CAL.—Residents of Piedmont have petitioned for a special election to vote on the issue of bonds for $40,000 for a sewer system. The proposed district embraces 700 acres.

SACRAMENTO, CAL.—The city engineer has been directed to prepare plans and specifications for a complete system of sewers for the city.

UKIAH, CAL.—We are informed by G. W. Parker, trustee, that the question of issuing bonds for $60,000 for a small pipe sewer system will be submitted to a vote of the people at an early date.

TACOMA, WASH.—Jas. M. Morrison, Cy. Engr., is preparing plans for a large sewer in the southern section of the city.

VANCOUVER, WASH.—M. G. Lisher, Cy. Engr., informs us that the city council is talking strongly of constructing sewers in seven streets, the mains to run south from 13th St. to the Columbia River. The total length will be about three miles, and the maximum grade about 2.2%.

STREETS.

LOWELL, MASS.—The council has appropriated $50,000 for paving for the coming season.

SPRINGFIELD, MASS.—The committee on streets has decided to abolish the use of red gravel, for which $23,000 was appropriated last year, and to recommend that granite paving be laid in three streets, that eight streets be macadamized, and perhaps additional brick paving.

BUFFALO, N. Y.—It is claimed that more paving will be done this yeaf than was done last, when 24 miles of street were paved, including 19.5 miles with asphalt. The cost last year was $1,268,310.

BELLEVUE, PA.—The council is considering the issuing of bonds to pave the principal streets.

PHILADELPHIA, PA.—The councils' committee on highways has agreed to report favorably ordinances providing for repaving with asphalt small streets in the so-called "slum" district; streets not occupied by street passenger railways with Belgian blocks and asphalt, and streets adjacent to Broad St. with Belgian blocks taken therefrom.

CARBONDALE, PA.—Bids will be received until April 10 for paving two streets with vitrified brick on concrete. Walter Frick, Cy. Engr.

ERIE, PA.—Bids for paving 17th St. with vitrified brick have been rejected and the work will be re-advertised.

MONONGAHELA CITY, PA.—Bids will be received until March 27 for 6,000 sq. yds. of vitrified brick paving and 2,000 lin. ft. of sandstone curbing. Geo. D. Jenkins, Cy. Engr.

WASHINGTON, D. C.—The district commissioners will receive bids until April 12 for repairing concrete pavement for five years; also for laying sheet asphalt, asphalt blocks, granite block and vitrified brick pavements, and until April 13 for furnishing granite curbing and granite paving blocks. It is reported that work will begin next month on about 40,000 sq. yds. of asphalt pavement, 24,000 of granite block, and 3,500 of brick.

JACKSONVILLE, FLA.—In addition to the 27,000 sq. yds. of brick paving noted last week, the board of public works will receive bids until April 3 for 1,640 sq. yds. of paving with sapless cypress blocks.

PENSACOLA, FLA.—Palafox St. is to be paved with vitrified brick.

CLEVELAND, O.—Plans have been prepared for about 20 miles of paving, estimated to cost about $1,200,000, as follows: Dressed block Medina stone, 57,228 lin. ft.; common Medina stone, 24,179 lin. ft.; brick, 24,179 lin. ft.; asphalt, 8,512 lin. ft.

CINCINNATI, O.—The board of administration will receive bids until April 4 for paving Gorman St. with brick.

DAYTON, O.—Salem St. is to be paved at an estimated cost of $36,000 to $50,000, according to material.

RICHMOND, IND.—We are informed by L. E. Browne, Cy. Engr., that bids will be received until April 14 for 7,550 sq. yds. of paving with vitrified brick, and 2,800 lin. ft. of curbing with Berea stone.

PEKIN, ILL.—We are informed by John R. Siebert, Cy. Engr., that ordinances for paving have been passed by the council, and are waiting for the confirmation by the county court of the assessments.

BURLINGTON, IA.—The city council has appropriated $10,000 for street paving this year.

OREGON CITY, ORE.—Sidney Smith, Cy. Surv., has prepared specifications for paving 13 blocks with vitrified brick. About 1,200,000 brick will be required, and the council is investigating whether they can be made here or not.

SPOKANE, WASH.—It is thought that Riverside Ave. can be paved for $70,000, the estimate being $3 per sq. yd. for granite paving, $5 per ft. for flag crosswalks, and $1 per lin. ft. for curbing. The paving of other streets is also being considered.

TACOMA, WASH.—The city engineer estimates that it will cost about $70,000 to pave eight blocks of South Pacific Ave. with bituminous rock.

ELECTRICAL.

GLENS FALLS, N. Y.—It is reported that a dam will be built in the Hudson River and that an electric plant will be established to furnish light and power at this place, Sandy Hill, Fort Edward, Saratoga Springs and probably Lake George.

NEW YORK, N. Y.—The department of public charities will receive bids until March 30 for an electric light plant at Central Islip, Long Island, and one on Ward's Island.

READING, PA.—The contract for street lighting has been awarded to the Reading Electric Light Co., at $109.50 per year for arc lights and $20.40 for incandescent, each light to burn all night and every night.

LAKE CITY, FLA.—We are informed by Wm. R. Bush that he and his associates have been granted a 30-year franchise for an electric light plant. Bonds for $30,000, 6%, and to run 30 years, will be issued, the interest being assured by the franchise from the town.

NEWARK, O.—The city clerk has been instructed to advertise for bids for a municipal electric light plant.

YOUNGSTOWN, O.—We are informed by F. M. Lillie, Cy. Engr., that the special committee appointed to investigate the subject of street lighting has reported in favor of a municipal plant. The city is now using about 300 arc lights. Dr. N. B. Acheson, president of the council, can furnish information.

WILLIAMSTON, MICH.—At the village election March 13 the vote was 123 to 98 in favor of electric lights.

MILFORD, O.—Geo. H. Hill, Surv. of Clermont Co., informs us that the council has a contract with the Sun Vapor Gas Light Co., which does not expire till November. The present system, however, is not entirely satisfactory, and electric lighting is being discussed. If those interested will communicate with Mr. Hill, he offers to present their plans to the council.

ELKHART, IND.—The city clerk will receive bids until April 5 for 52 or more arc lights of 2,000 c. p.

OXFORD, IND.—At a recent public meeting it was proposed to construct an electric light plant at a cost of $9,600.

RICHMOND, IND.—We are informed by L. E. Browne, Cy. Engr., that street lighting by arc lamps is being considered.

SOUTH MILWAUKEE, WIS.—The South Milwaukee Light & Power Co., noted last week as incorporated, will put in a plant for furnishing 1,000 incandescent lights.

COLUMBUS, TEX.—A franchise for an electric light plant has been granted to Towell & Shaw who will put in a plant at once.

NEW COMPANIES.—Electric Propeller Co., Chicago, Ill.; $200,000; Wm. C. Marshall, D. C. King, L. C. Deproft. Chicago Electric Headlight Co., Chicago, Ill.; T. Van Smith, Arthur Horton, C. B. Ever. Spring Valley Electric Light Co., Peoria, Ill.; $25,000; E. B. Hillman, H. T. Hays, L. B. Bradley. Wyoming Electric Light & Power Co., Peoria, Ill.; $15,000; E. B. Hillman, H. T. Hays, L. B. Bradley. Pacific Electric Regulator Co., San Francisco, Cal.; $500,000; H. W. Chase, J. P. Moore, J. R. Hanify.

CONTRACT PRICES.

BRICK PAVING.—Easton, Pa.—We are informed by H. R. Fehr, Cy. Engr., that the contract for paving 10,614 sq. yds. with vitrified brick in Walnut and South 4th Sts. has been awarded to M. Miles & Son, at $2.31 per sq. yd. Brick made by the U. S. Fire Clay Co., Pittsburg, were selected, and a report of the tests will appear in a later issue.

Winona, Minn.—The contract for about 72,000 sq. yds. of brick paving has been awarded to Corry, Abbell & Co., at $118,430; the Menominee or Galesburg brick to be used. The bids were as follows: 1, 18 to 24-in. curbing, per lin. ft.; 2, 16-in. curbing; 3, curbing replaced; 4, paving, per sq. yd.:

	1. cts.	2. cts.	3. cts.	4. $
Corey, Abell & Co., Winona	53	40	20	1.44
O. C. Lamphier & Co., Galesburg	66	54	20	1.68
Botham & Blesanz, Winona	53	53	33	1.49
Des Moines Construction Co	60	48	20	1.44
Rockford Construction Co	58	48	15	1.45
Thos. Riley, St. Paul	60	50	10	1.495
Burke, Thatcher & Co., West Superior	60	50	20	1.42
South Bend Construction Co	60	48	25	1.58
Henry Bessler, Cedar Rapids	60	50	20	1.62
Geo. S. Miller, Council Bluffs	57	52	20	1.46
Dubuque Construction Co	60	50	30	1.51
John Lohse, Winona	58	48	20	1.47

PAVING BRICK.—Washington, D. C.—The following bids were received March 10 for 400,000 paving brick: New National Brick Co., $9 per M.; Ivy City Brick Co., $9.60; Frederick Brick Works, $10.50.

GRANITE BLOCKS.—Bangor, Me.—P. H. Coombs, Cy. Engr., informs us that the contract for granite paving blocks was awarded March 14 to the Jewell Granite Co., Bangor (quarries at Lincoln), at $51.875 per M. for the regular size, and $30.75 for blocks 4 × 4 × 4 ins.

STREET SUPPLIES.—New Haven, Conn.—Contracts for annual supplies have been awarded as follows: C. W. Blakeslee & Son, Belgian blocks, 96 cts. per sq. yd.; E. Cunningham, cobble stones, 28¾ cts. per sq. yd.; Sessions Foundry Co., Bristol, sewer castings, 1.6 cts. per lb.; Jos. Lazzari, Stony Creek, granite basin heads, $28.50 per set.

DREDGING.—Baltimore, Md.—The harbor board has awarded a contract for dredging about 100,000 cu. yds. of mud to the Baltimore Dredging Co., at 16¾ cts. per cu. yd. Thos. P. Morgan, Washington, D. C., bid 14.3 cts. per cu. yd. for the work.

MISCELLANEOUS.

DOCK.—Duluth, Minn.—A new ore dock 2,370 ft. long, and similar to the one now being built, will be built this summer by the Duluth, Mesabic & Northern Ry.

PLATFORM ON PILES.—Brooklyn, N. Y.—The commissioner of city works will receive bids until March 29 for a platform on piles near the mouth of the Wallabout Canal.

LOCK.—Albany, N. Y.—The superintendent of public works will receive bids until March 28 for rebuilding lock No. 76 on the Black River Canal. The work includes about 2,880 cu. yds. excavation, 1,300 cu. yds. embankment, 1,000 cu. yds. masonry in lock walls, 150 cu. yds. concrete masonry, 36,000 ft. B. M. lumber, 9,000 lin. ft. bearing piles, 2,000 lbs. wrought iron, also cast iron, cement, etc. Specifications may be seen at the office of J. W. Manley, Supt. canal repairs, Utica.

GRANITE STONES.—New York, N. Y.—The department of docks will receive bids until March 30 for about 21,823 cu. ft. of granite stones for bulkhead or river wall. The estimate calls for 1,092 pieces of granite, consisting of 546 headers and 546 stretchers.

GARBAGE DISPOSAL.—Buffalo, N. Y.—The following bids were opened March 14 for the sanitary destruction of the city garbage: Baynes Garbage Crematory Works, Buffalo, $175,000 for five years, or $40,000 for one year; Rider Garbage Co., Pittsburg, Pa., $170,000, or $30,000; Simonin & Simonin, Philadelphia, Pa., $150,000 for five years.

STREET CLEANING.—Brooklyn, N. Y.—The following bids were received March 14 for the cleaning of streets and removal of ashes for three years from April 1; Robert Furey, cleaning streets, $23 a mile for each year; removing ashes, $190,000 for each of the first two years and $215,000 for the third year. Chas. Hart, cleaning streets, $27, $30 and $33 per mile for the first, second and third year; removing ashes, $200,000, $230,000 and $240,000 per year. Norton & Gorman, cleaning streets, $25.60, $26 and $27; removing ashes, $180,000, $180,000 and $190,000. The price paid under the old contract for street cleaning was $22.25 a mile; removing ashes, $140,000 in 1890, $144,000 in 1891 and $148,000 in 1892. The new contract will be made on the basis of 20,000 miles of streets to be cleaned, the commissioner having the power to increase the amount.

NATURAL GAS COMPANY.—Pleasanton, Cal.—The Pleasanton Petroleum & Natural Gas Co. has been incorporated by Wm. Naper, Joshua Chadbourne and others; capital stock, $100,000.

INDUSTRIAL NOTES.

LOCOMOTIVES. — The Schenectady Locomotive Works, Schenectady, N. Y., have built 9 mastodon or twelve-wheel engines for the ore traffic on the Duluth & Iron Range, cylinders 22 × 22 ins., eight drivers 4 ft. 6 ins.; they are also building for exhibit at the World's Columbian Exposition, a large model of the eight-wheel engines with 7-ft. drivers, which haul the Empire State express on the New York Central. The Brooks Locomotive Works, Dunkirk, N. Y., are building 10 freight and 5 switching engines for the Toledo & Ohio Central; also 20 ten-wheel passenger engines, with cylinders 19 × 26 ins., and 25 mogul freight engines, with cylinders 19 × 24 ins., for the Great Northern; an engine of each of the two latter types will be sent to the World's Columbian Exposition. The Manchester Locomotive Works, Manchester, N. H., have an order for 7 engines for the Bangor & Aroostook.

CARS.—The American Car Co., Basic City, Va., has an order for 250 freight cars for the Chesapeake & Ohio; Pres. and Gen. Man., C. D. Pettis, Chattanooga, Tenn. The Jackson & Woodin Car Co., Berwick, Pa., has an order for 500 coal cars of 60,000 lbs. capacity for the Delaware, Lackawanna & Western. The Barney & Smith Car Co., Dayton, O., has an order for 2 dining cars for the Lake Shore & Michigan Southern. The Lima Car Works, Lima, O., have an order for 250 freight cars. The Buffalo Car Mfg. Co., Buffalo, N. Y., has an order for 500 box cars, 100 flat cars and 100 stock cars for the New York Central; all to have the Fox pressed steel truck frames. The Canadian Pacific has built a complete passenger train at its Montreal shops, to run between Montreal and Chicago.

THE CARSON TRENCH MACHINE CO., Boston, Mass., owns numerous patents upon appliances for the rapid and economical excavation of sewer and water pipe trenches. Mr. Fuller, the manager, states that during the year 1892 they were used in more than 50 cities throughout the country.

THE NATIONAL PAINT WORKS, Williamsport, Pa., have had their paint used on some very extensive iron-work structures, including 8½ miles of the Chicago & South Side Elevated Ry., 3½ miles of the Brooklyn Elevated Ry. and five of the main buildings of the World's Columbian Exposition. These are among the largest orders for paint ever placed.

VANDERBILT & HOPKINS, New York, N. Y., dealers in lumber and ties, will move their office May 1 to 126 Liberty St., New York.

THE SARGENT CO. is the new name of the Congdon Brake Shoe Co., of Chicago, and the business established by the latter in 1876, confined at first to the introduction of the Congdon brake shoe, and developed since into a general brake shoe, iron and steel castings business, will hereafter be carried on under the former name. The company states that this change in name does not imply any change in policy or ownership, but has been rendered advisable by the expansion of business. It has a large business in steel castings from railway companies and manufacturers, in addition to the brake shoe business, which has kept the iron foundry up to its full capacity for the last year, and rendered necessary the introduction of improved methods, giving the works a larger capacity.

NEW COMPANIES.—Washington Sewer Cleaning Co., Washington, D. C.; $100,000; to operate the Knowles sewer cleaning device; C. W. Hayes, C. C. Duncanson and W. H. Rutherford. Grand City Brick, Tile & Terra-Cotta Co., Chicago, Ill.; $100,000; Isaac T. Dyer, W. B. Bass and C. F. Hyndman. Illinois Garbage Treating Co., Chicago, Ill.; $300,000; W. E. Sharps, Henry Best and M. R. Fletcher.

INDUSTRIAL SUPPLEMENT TO ENGINEERING NEWS

NEW YORK, MARCH 23, 1893.

HENRY R. WORTHINGTON.

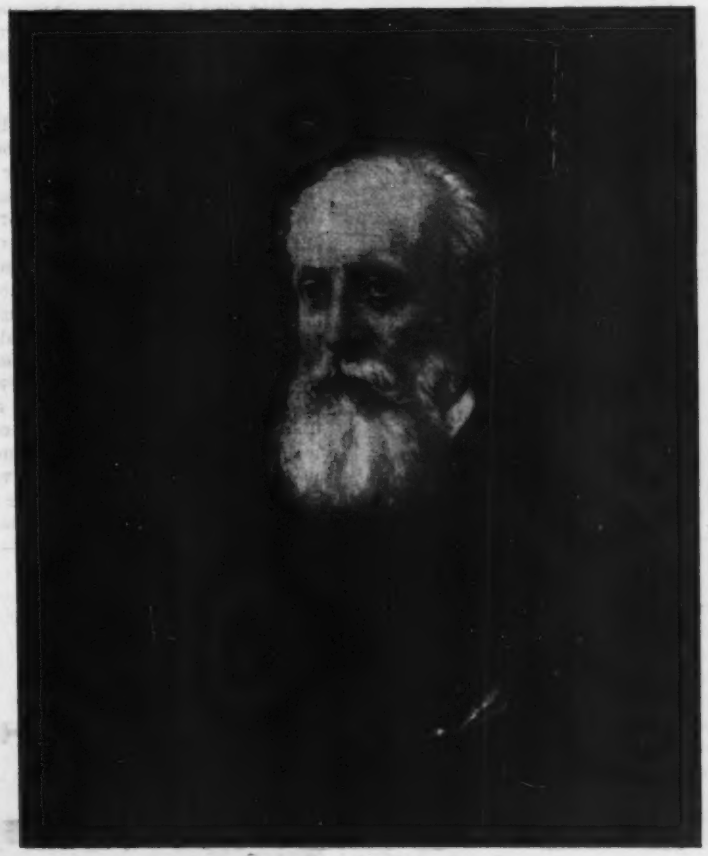
Henry Rossiter Worthington, whose name is inseparably connected with the history and development of modern pumping machinery, was born in Brooklyn, N. Y., on Dec. 17, 1816. His father was a New York merchant, and the son was without special training in the mechanical sciences; but an early predilection to studies of this nature, aided by natural aptitude and ability, led him on until he discovered a new method of using steam for raising water; and he lived long enough to see this discovery perfected and the industry he founded take high rank in extent and importance among the manufactures of his own and foreign countries.

Like many other important inventions, the direct-acting steam pump was the outcome of what was at the time considered a much more important line of investigation. In the year 1840 the young inventor, attracted by the honor and reward offered for success by his native State, designed a steam canal boat for use on the Erie Canal. Up to this time steam engines were made to pump their own feed-water into the boilers; and with uninterrupted action this was possible. But the service on the canal presented unexpected difficulties in this direction. The boat was liable to detention along the line of the canal, and especially at the many locks, and at first a hand-pump was brought into requisition for keeping up the boiler supply. The steam canal boat was not a commercial success; but the experience gained with the hand feed-pumps led Mr. Worthington to turn his attention to a device for accomplishing the same end without the aid of manual labor, and the result was an independent steam feed-pump, patented Sept. 7, 1841.

In the original machine this feed-pump was automatic in its action; a float in the boiler cutting off the steam from the pump when the boiler was full. But though the device was very successful, its inventor appreciated the dangers incident to any contrivance for superseding the attention and responsibility of attendants, and ever after dreaded and condemned them.

This first direct-acting pump, of which further particulars are elsewhere given, is generally believed to have been the beginning of the numerous class of inventions which followed for storing power to act upon the steam-valve when the momentum of the moving parts was insufficient to throw it through its full distance of travel. But Mr. Worthington did not stop here. While the direct acting pump was well adapted to feeding boilers and for supplying moderate quantities of water under a moderate head, it still had some very objectionable features. The chief of these was that the action of the pump-plunger, or piston, was an intermittent one, as the column of water, started into motion at the beginning of each stroke, came to a stand at the end of the stroke. This caused an irregular flow of water and severely strained both the pumps and the pipes. Mr. Worthington devoted much time and study to correcting these evils, and in a few years, after perfecting many types of single cylinder pumps, he brought out the direct-acting duplex steam pump. In 1845 Mr. Worthington began the manufacture of steam pumping engines, and founded in South Brooklyn the very extensive works which still bear his name, and are conducted by his son and men who were early associated with him.

He perfected pumping engines for municipal water-supply, and in the face of hard-grounded prejudice and the opposition of engineers who still believed in older methods, he gradually but surely introduced these pumps to public notice and favor. At the present time Worthington pumps are found doing duty in every city of the United States; they are made in both England and France as well, and can be found almost everywhere in the world where pumping machinery of any sort is used. Specially designed high pressure pumps of this type are used for forcing crude oil to the seaboard, across Pennsylvania and New York States, and across the mountains of Asiatic Caucasia on the line from Baku to Batoum, on the Black Sea. The water meter invented by Mr. Worthington is also a most ingenious, successful and widely used device.



HENRY ROSSITER WORTHINGTON.

Mr. Worthington was a member of the American Society of Civil Engineers, and vice-president and honorary member of the American Society of Mechanical Engineers. He was an intimate friend of John Ericsson; and that famous engineer, in forwarding a history of his own inventions, said to Mr. Worthington: "In view of the insuperable difficulties to be overcome, I regard your hydraulic engine as one of the greatest triumphs in modern engineering." In this connection, and as showing the long existing friendship between these two men, it may be mentioned that Mr. Worthington sought and obtained the assistance of Mr. Ericsson in designing the hull of the steam canal boat mentioned above, and that eminent Swede took part in the trial trip in New York harbor and expressed his general satisfaction with its working.

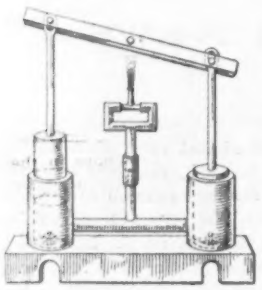
As this steam canal boat was indirectly the parent of the pumps which have made Mr. Worthington famous, it may not be out of place to describe it in a little more detail. As elsewhere shown by a photograph of the original model, the pair of paddle-wheels was located at the bow of the boat and under an over-hanging and protecting deck, or guard. A single horizontal, non-condensing engine operated the wheels. A screw at the bow was also tried, but abandoned as less efficient than the wheels; but the purpose of putting either type of propeller at the bow of the boat was to break the swell produced by the forward movement, and thus to reduce the wash upon the bank. One of these boats made a number of trips over the Erie Canal to Buffalo; and on one occasion, by breaking up the thin ice, a path was made for a number of ordinary boats that otherwise would have been frozen up for the winter. But the prejudices of the canal boatmen were too strong for the new craft, and of the four boats built one was sent to Lake Champlain and another did service for some years on Chesapeake Bay. They will always figure, however, in the true history of the direct-acting and the duplex steam pumps.

Mr. Worthington died, after a brief illness, on Dec. 17, 1880, on the sixty-fourth anniversary of his birth.

THE EVOLUTION OF STEAM PUMPING ENGINES.

IT IS impossible now to determine with any certainty who invented the first pumping engine, as distinguished from the more ancient and simple method of lifting water by a sweep or chain of earthen pots. Some investigators, on very meager information, ascribe this honor to one Danaus, who is said to have been a brother of the Egyptian monarch Rameses I., and who is credited with having dug the wells in Argos, 1485 B. C. Hero, in his "Spiritalia," written about 150, B. C., among a number of other curious mechanical devices, describes a forcing pump which he says was invented by Ctesibus of Alexandria, at one time a barber and later one of the leaders in the

famous Greek schools of that city which flourished under the auspices of the Ptolemies.



PUMP OF CTESIBUS.

As described by Hero, and here illustrated from this description, the pump of Ctesibus was strikingly similar in general design to the fire-engine of our grandfathers. It had two single-acting pumps worked by means of a brake, and the two streams, uniting in a common discharge pipe, passed up a trunk, which was provided with an air-chamber, and the water was finally discharged from a nozzle which was so formed as to permit its being turned in any direction.

As the two Egyptians Danaus and Ctesibus are the only two names preserved in connection with the original invention of engines for pumping water, it is safe to say that this device had its origin in Egypt, that great center of ancient civilization. But it may be also said that it is not probable that either the valve or the piston was original with Ctesibus. The valve is said to have been used at a very remote date in the bottom of the earthen pots of the Egyptian "noria," or chain of pots passing over a wheel, and was put there to reduce the resistance of entry into the water. The piston, too, was a very ancient device used in the blowers of the crude smelting furnaces of Asia; and its introduction probably dates from the earliest use of metal.

In any event, the invention of the Alexandrian mechanic seems to have been of little practical value, for his engine would force, but would not lift, water; and it was for the latter purpose that machines were most wanted in irrigated Egypt. The effect of atmospheric pressure upon fluids was neither studied nor understood in the infancy of hydraulic science; and though the Moors of old Spain described this effect, it was left for the Italian Torricelli, about A. D. 1644, to determine correctly its real influence. It is a surprising fact that the piston-pump, once discovered and described, should have been entirely laid aside for eighteen or twenty centuries, and that the expansive power of steam, plainly demonstrated by Hero, 150 B. C., and actually used by him in expelling water from a closed vessel, should have been utterly fruitless of useful results in all these long years.

PORTA'S STEAM FOUNTAIN.

But neither steam nor the piston-pump is heard of again until near the end of the eighteenth century after Christ—in the air-pump of Otto Guericke, of Magdeburg, and in the steam-engine of Dr. Papin, of Blois, France. Previous to this time, however, about A. D. 1500, that marvelous engineer-artist-soldier Leonardo da Vinci had successfully used steam in a steam-gun; and Baptista Porta and the mythical Solomon de Caus, about 1600-1629, practically repeated the water-raising experiments of Hero, by lifting water a short distance above a closed tank by the pressure of steam upon the water surface. In 1633 the Marquis of Worcester, experimenting in the same line with Porta and De Caus, invented his "water-commanding engine," which though much more complicated was really inferior in value to the simple devices of his predecessors in the attempted utilization of steam pressure.

DENYS PAPIN.

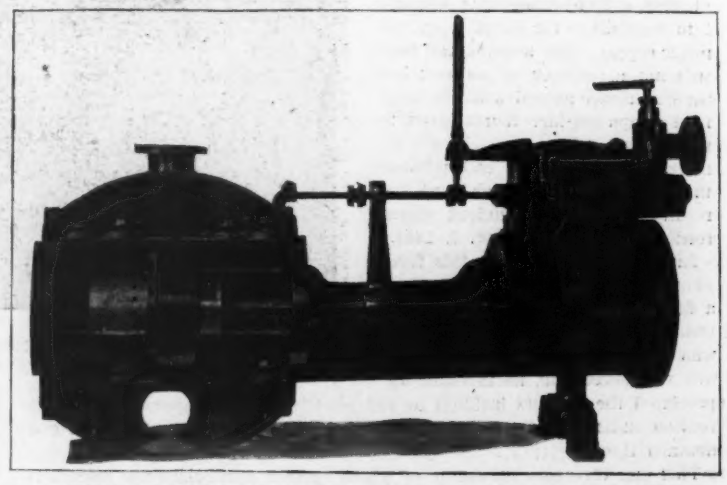
But the real inventor of the steam engine was doubtless Denys Papin (1647-1712), a doctor of Blois, who turned his attention to mechanics and became the assistant of the Dutchman Huygens. As early as 1690 he published the result of his labors, proposing steam as a universal motive power, and describing a steam engine and even a rude paddle-wheel steamer. His last published work was a Latin essay upon "a new system for raising water by the action of fire," printed in Frankfort in 1707. But Papin was a Protestant, at a time when that term meant persecution; and more than this, he was an inventor appearing before the world could realize or was ready to utilize the fruits of his genuis. He was called a dreamer, and was fated to meet all the trials and reverses incident to the above conditions.

While Papin did more than all his predecessors in making a somewhat useful machine of the steam-engine, his engine yet belonged to the steam-fountain type of Hero, Porta, De Caus and the Marquis of Worcester. It could only be utilized for lifting water by the direct pressure of steam, and any work derived from it was obtained by again using this lifted water in turning a wheel. But to Papin is ascribed the reinvention of the piston, the invention of the safety-valve, the method of charging the water-chamber by atmospheric pressure, incident to the condensation of steam therein; and by condensing the air in an air-chamber placed at the summit of the discharge-pipe he utilized its elasticity in securing a continuous instead of an intermittent discharge. Papin also invented the atmospheric steam-engine, which, crude as it was, was the first true engine devised since the aeolipile of Hero.

THOMAS SAVERY.

After Papin came Thomas Savery, about 1700; and Thomas Newcomen, in 1705. Both of these men simply improved upon the Frenchman's ideas; and the same can be said of the so-called steam-engines of Desaguliers, Leupold, Blakely, and Smeaton. Newcomen, Savery and Smeaton made working machines which were used to a limited extent in mine-pumping, and crude as they were they remained the prevailing type of pumping engine until about A. D. 1764. About this time the famous James Watt appeared upon the scene, and at last gave to the world a practical steam engine, the real prototype of the magnificent pieces of mechanism of the present day. Watt substituted the pressure of steam for the pressure of the atmosphere upon the piston-head by using a closed cylinder; and finding that he could obtain a pressure greater than that due to the atmosphere, when the space below the piston was nearly a vacuum, he constructed the double-acting engine. With Watt, the history of the steam-engine is left; as it is not the purpose of this article to pass in review the procession of men and events that led up to the perfected engine of to-day.

But in this summary of the evolution of the pumping-engine it will not be out of place to give a short sketch of another early class of water-raising machines; those operated by water-power and put to important use in the seventeenth and eighteenth centuries in Europe. One of the earliest and best described of these is the "Machine-de-Marly," actually built by the French engineer Rannequin, in 1682, and used for raising water for the fountains of Marly and Versailles. The works were located on the Seine, and consisted of 14 water-wheels which first raised the water to a cistern 150 ft. above the river and 600 ft. distant. A crank on the axle of one of the water-wheels communicated motion to a balance-beam and this in turn operated the piston rods of four pumps on each side of the wheel, which sucked and forced water alternately. The water was lifted ultimately to a point 502 ft. above the river and 3,684 ft. distant from it, in three lifts, the power being carried by rod-and-chain connection from the



MODEL OF DIRECT-ACTING PUMP ON STEAMER "WASHINGTON," 1850.

water wheels in the river to the first and second cisterns up the hill. From the final tower or reservoir the water was carried in an aqueduct to the fountains. This piece of magnificence is said to have cost "le Grand Monarque" the sum of $1,600,000 for the pumping plant alone.

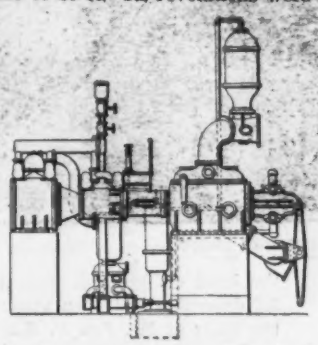
It is a curious fact, in view of the applications of steam power in every industry at the present day, that the early inventors who worked on the steam engine down to the time of Watt devoted their energies chiefly to the application of steam to the work of pumping water. Yet on a little thought it is easy to see the reason. Modern mills and factories were not dreamed of. The "mills" of the eighteenth century were chiefly mills for grinding grain, for which water power, wind power or horse power answered well enough. If in the days of the Newcomen engine a man had prophesied that the steam engine would some day compete with the water-wheel for driving mills he would have been laughed at. The place where the steam engine filled a great want was at the coal mines, many of which had already reached a depth at which drainage was an insurmountable obstacle to further work. Water power for pumping was seldom available, and transmission of power to any distance was a problem wholly untouched. But the steam engine, crude and imperfect and wasteful as it was, could pump the water from the mine shafts, which otherwise must have been

abandoned. The matter of economy of coal was comparatively unimportant in this case. It was a short step from this use of the pumping engine to its use for furnishing cities and towns with a water supply, which had heretofore depended chiefly on water power pumps.

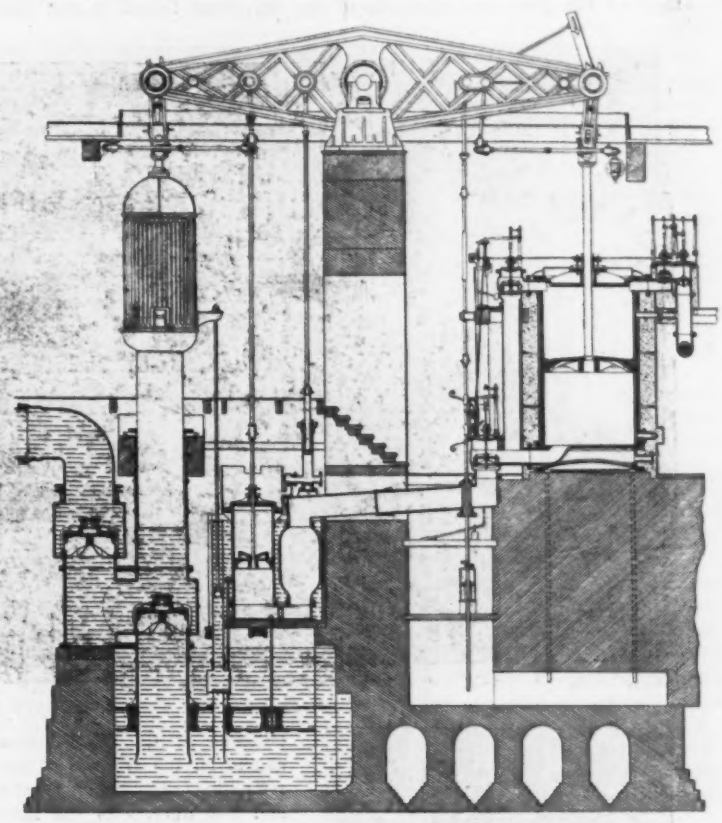
Such was the story of the evolution of the earliest pumping engines, and the type of machine which resulted is still known as the Cornish pumping engine from its extensive use in the mines of Cornwall. It is astonishing what an overpowering influence is the force of precedent, especially among the older nations of the world. The huge, unwieldy and enormously expensive Cornish pumping engine is yet in extensive use and still finds some favor among English engineers. Even in the variations which have been made from it, many of the features in design, which date back to the days of Watt, have been retained, and the machine continues to be of enormous bulk for the power generated.

The Cornish type of pumping engine reached its highest development about 1840; and engines erected since of the Cornish type are practically copies of the earlier engines. It was in 1840 that a young American inventor, Henry R. Worthington, began experiments which were to result eventually in the evolution of a pumping engine of wholly different type—the modern direct-acting engine. To present to our readers the contrast between the two machines we show herewith an engine of each class of equal power drawn to the same scale. The Cornish engine shown is one which was subjected to careful tests in 1840 by Thos. Wicksteed, engineer of the East London Water Works. Its enormous steam cylinder was 6 ft. 8 ins. in diameter, and it had a stroke of 10 ft. Its revolutions were from 6 to 7 per minute. At an average speed of 6½ revolutions it pumped 6,000,000 gallons of water per 24 hours, against a head of 108 ft.

The engine which stands beside it is a compound direct-acting Worthington engine, built in 1889 for the waterworks of Jersey City, and of equal capacity with the ponderous Cornish engine. A half dozen such engines could be set upon the floor space occupied by the Cornish engine, and the contrast between the two machines in height is evident.



WORTHINGTON ENGINE, JERSEY CITY WATER-WORKS.

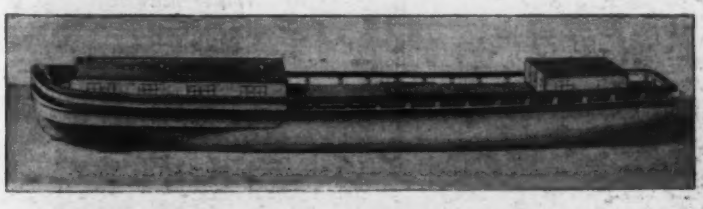


CORNISH ENGINE, EAST LONDON WATER-WORKS.

(The above are drawn to the same scale. Each engine is of 6,000,000 gallons daily capacity.

Turning now to the history of the direct-acting type of engine, it had its first origin in 1840, just at the time when its rival had attained its greatest perfection. Like many other great inventions its beginnings were exceedingly small. In the sketch of the life of Mr. Worthington we have told the story how his labors in the invention of a steam canal boat had the wholly unexpected result of evolving the first direct acting steam pump.

It is a remarkable illustration of the embryotic state of the mechanic arts

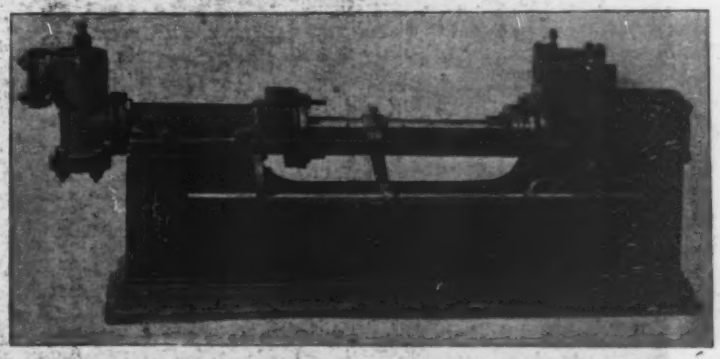


HENRY R. WORTHINGTON'S STEAM CANAL BOAT, 1840.

a half century ago, that an inventor of that day working on the still imperfectly solved problem of a steam canal boat, should find himself balked for lack of a device to feed his boiler while the boat was standing at a lock. A little thought, however, makes the situation clear. The steam engine of that day always had a pump attached for feeding its boiler. The injector, Gifford's wonderful invention, was not brought into use until 1858, and the numberless feed pumps and boiler feeders of the present day were wholly non-existent. It is true that inventors were at work on the problem of a direct-acting steam pump, but no one had as yet achieved success. The point of difficulty was the movement of the valves. It was easy to place a steam cylinder and water cylinder in line and mount their pistons on a common rod, and easy to mount tappets on the valve gear so that at the end of its stroke the pump would shift the steam valve, but if the momentum of the piston failed to move the valve the pump would stop and it was difficult to make the operation quiet and free from shock. In Mr. Worthington's first pump the valve was moved by a spiral spring which was compressed during the stroke and released at the proper point for throwing the valve. For over three years Mr. Worthington devoted much labor and ingenuity to the perfection of spring actuated valves; but he finally abandoned this class of devices and adopted an auxiliary steam piston for driving the valve. For nine years, amid great discouragements, Mr. Worthington labored to perfect the direct-acting pump. If he was successful in introducing a pump, the slightest disarrangement of the parts was sufficient excuse for its abandonment. Prominent engineers discouraged the young inventor's work. Jas. P. Allaire, the famous marine engine builder, in all kindness assured Mr. Worthington that he was trying to invent a machine which was not needed or wanted, as no part of steamboat or factory machinery was more complete or satisfactory than that for pumping. Another engineer of high standing praised the inventor's ingenuity, but warned him that novelty would be a hindrance to success, saying: "If you expect to bring these things into general use, you must contrive to have a man see something he has seen before in his life, when he takes the cover off from a steam chest."

Acting on this advice, Mr. Worthington attacked the problem anew, and in conjunction with his partner, Wm. H. Baker, patented on April 3, 1849, a "relief valve motion," which by its simplicity, durability and reliability gave the direct-acting pump a favor it had not before enjoyed. This measure of success stimulated the inventor to further exercise of his ingenuity; and many variations in construction, without departure from the original principle, were devised. In a pump placed on the steamer "Washington" in 1850 a large number of small low-lift water valves were substituted for the single large high-lift valve, which was then standard practice. The valve adopted was a plain india-rubber disc ½-in. thick, covering a series of ½-in. holes, and with a lift of not more than ¼-in. This innovation in pump construction has now become universal practice for all large pumps working under high heads.

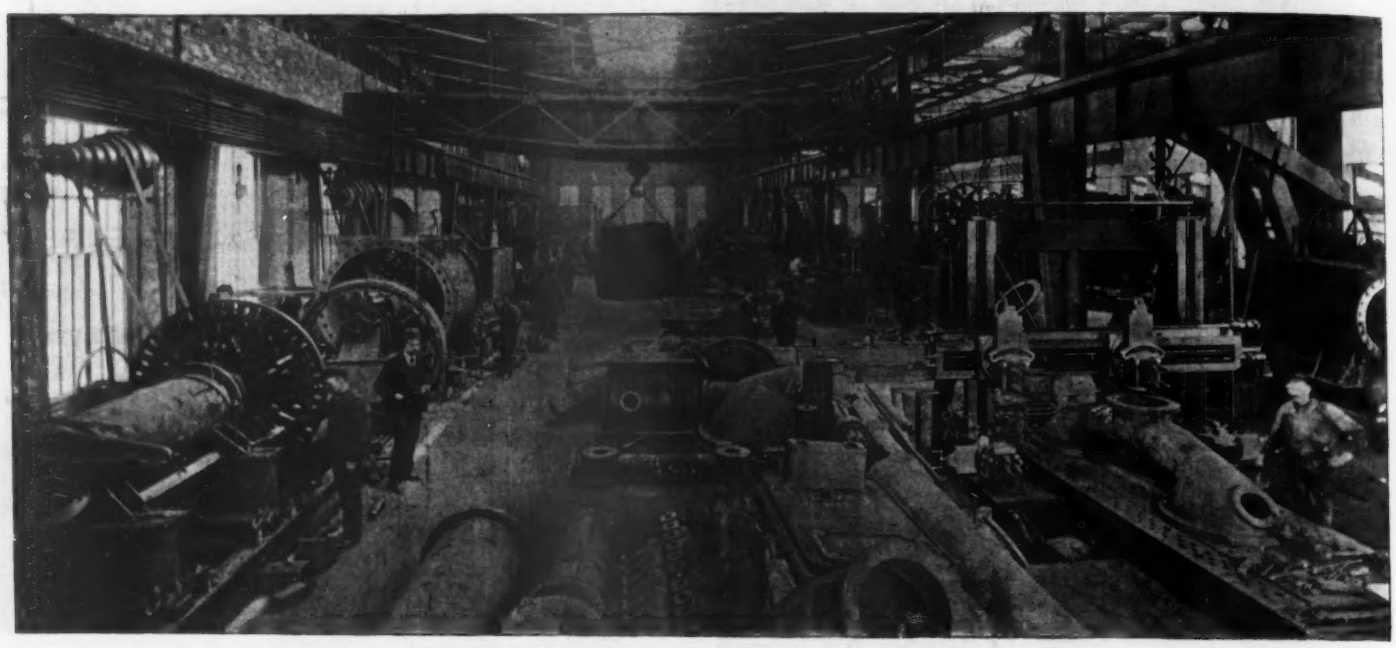
In 1855 a new departure was made. The first direct acting steam pump



THE FIRST DIRECT-ACTING STEAM PUMP, 1840.

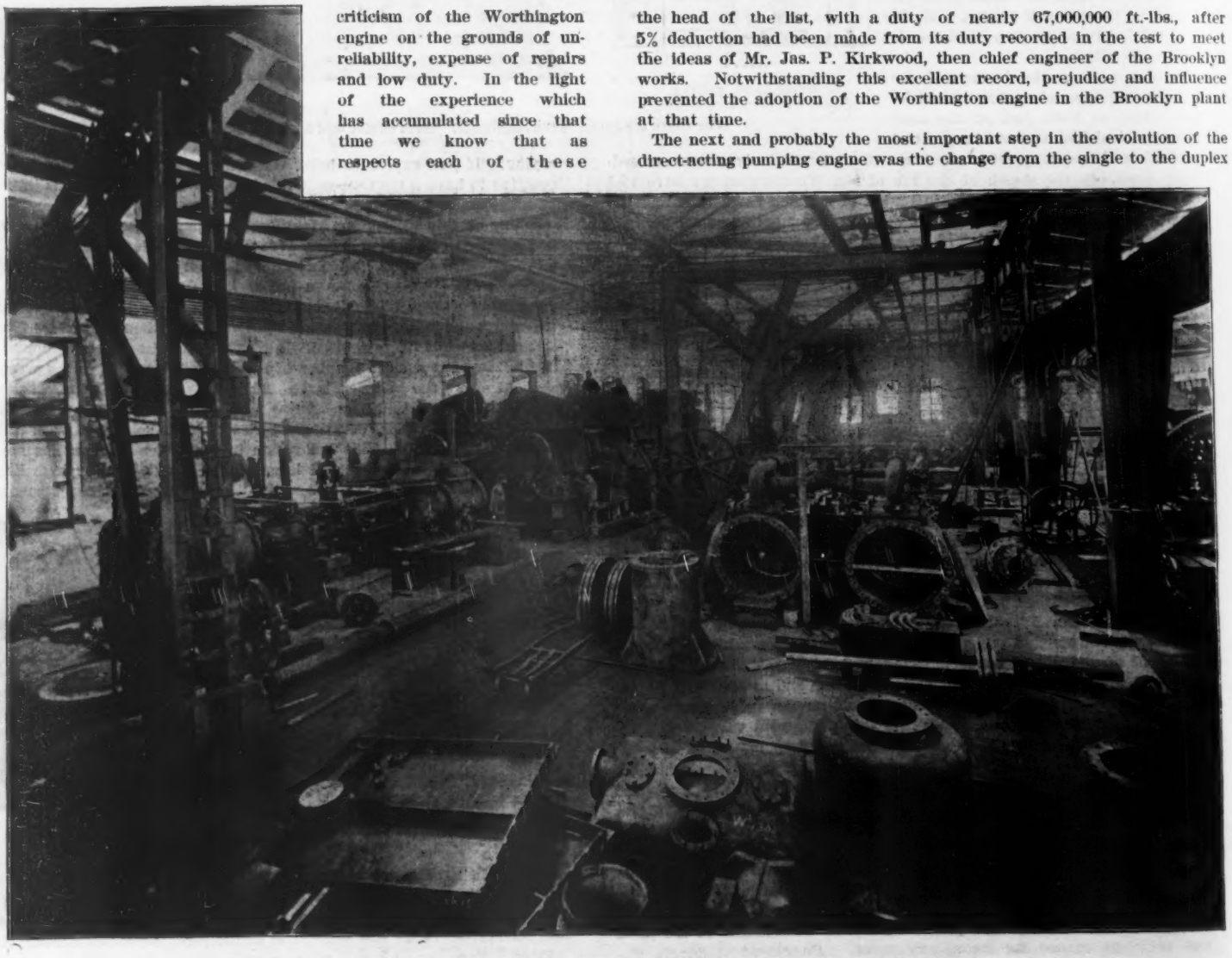
was installed for water supply service at Savannah, Ga. It was a compound engine, the low-pressure cylinder being in the form of a ring surrounding the high-pressure cylinder. In the following year a duplicate of the Savannah engine was erected at Cambridge, Mass., its capacity being 300,000 gallons per 24 hours, which sounds ridiculously small in these days when 20,000,000-gallon pumping engines are not uncommon.

These two engines, especially the one at Cambridge, created great interest among the leading hydraulic engineers. The Cornish engine was up to that time the standard type of pumping engine for water-works service. That the new engine was far smaller and cheaper was apparent, and the advocates of the Cornish engine, among whom were numbered most of the prominent engineers of the day, were forced to rest their criticism of the Worthington engine on the grounds of unreliability, expense of repairs and low duty. In the light of the experience which has accumulated since that time we know that as respects each of these particulars as well as in compactness the Worthington engine was in advance of the Cornish. To settle the question of duty the authorities of the Brooklyn Water-Works caused extensive tests to be made on the Cambridge engine, on Jersey City's Cornish engine at the Belleville pumping station, on a Philadelphia Cornish engine, and on the crank engine of Dickerson & Sickles at Hartford, Conn. The Worthington engine stood at the head of the list, with a duty of nearly 67,000,000 ft.-lbs., after 5% deduction had been made from its duty recorded in the test to meet the ideas of Mr. Jas. P. Kirkwood, then chief engineer of the Brooklyn works. Notwithstanding this excellent record, prejudice and influence prevented the adoption of the Worthington engine in the Brooklyn plant at that time.



THE HEAVY MACHINERY SHOP.

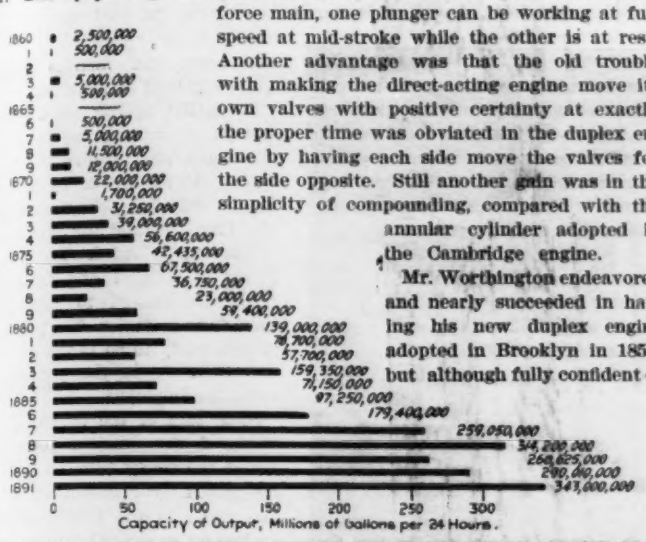
The next and probably the most important step in the evolution of the direct-acting pumping engine was the change from the single to the duplex



SOME LARGE PUMPING ENGINES AND ELECTRIC JIB CRANES IN THE HEAVY ERECTING SHOP.

type. The single cylinder engine must necessarily work at very slow speed, as the water in the force main has to come to rest and acquire velocity at every stroke of the pump, except for the equalizing effect of the air-chamber. But by placing two cylinders side by side delivering into a common force main, one plunger can be working at full speed at mid-stroke while the other is at rest. Another advantage was that the old trouble with making the direct-acting engine move its own valves with positive certainty at exactly the proper time was obviated in the duplex engine by having each side move the valves for the side opposite. Still another gain was in the simplicity of compounding, compared with the annular cylinder adopted in the Cambridge engine.

Mr. Worthington endeavored and nearly succeeded in having his new duplex engine adopted in Brooklyn in 1857; but although fully confident of its merit he was obliged to wait six years, until 1863, to see it put in water-works service. In that year a 5,000,000-gallon engine was installed at Charlestown, Mass., under guarantee that it should give a performance at least equal to that of any engine in the United States under penalty of removal in one year in event of failure. The engine was not removed, but two others were subsequently added and are still at work.



THE ANNUAL OUTPUT OF PUMPING ENGINES FOR WATER-WORKS SERVICE FROM THE WORTHINGTON HYDRAULIC WORKS, 1860 TO 1891.

Opposite each year is given the total capacity (in gallons per 24 hours) of all the engines turned out in that year.

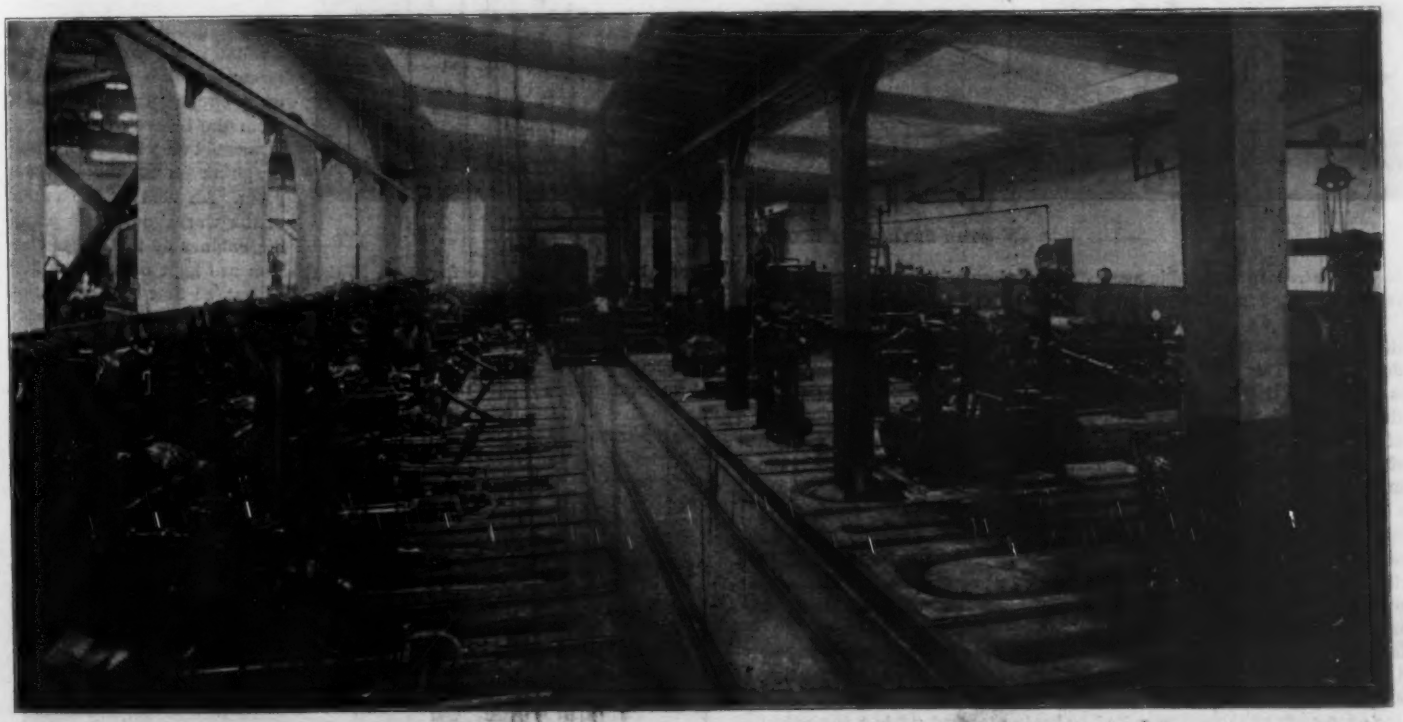
The succeeding history of the Worthington pumping engine is the record of the steady and prosperous development of a great industrial enterprise. How recent is the enormous expansion which the industry has undergone is well shown by the accompanying diagram showing the annual output of Worthington pumping engines for use on water-works service alone from 1860 to 1891. Besides pumps for water-works service the Worthington establishment has every year turned out a great number of steam pumps for draining mines, feeding boilers, and for the countless other uses to which the steam pump is applicable, and has manufactured great numbers of the water meters invented by Mr. Worthington, which was the first American water meter to come into extensive use.

One more important fact remains to be recorded to complete this history of the direct-acting pumping engine. As we have already stated, one of the earliest direct-acting pumps installed on water-works service was able to prove itself quite the equal of its competitors of that day in economy of fuel. But with the lapse of years new types of pumping machinery came into use, with duties much higher than the old Cornish engines had ever touched. The direct-acting pump was by the very principle of its construction unable to compete in economy with these engines, for the steam had to follow the piston through nearly the full stroke. The question how this competition should be met became one of much importance to those in charge of the Worthington firm. In 1884 the problem was solved by the invention and perfection of the "high duty attachment." This ingenious and simple invention consists of a pair of oscillating cylinders whose plungers are driven directly from the cross-head of the main engine. They store up the power generated by the steam cylinder during the first part of the stroke and give it out on the last part, thus permitting an early cut-off of the steam in the cylinder, a high ratio of expansion and consequent economy in fuel consumption. Up to Jan. 1, 1892, 80 of these high duty engines had been installed, including not only engines for the United States and Canada, but engines for England, Wales, Germany, Russia, Australia, Bolivia, Uruguay, and the Argentine Republic.

THE WORTHINGTON HYDRAULIC WORKS.

Nearly half a century ago Henry R. Worthington started in what was then the open fields south of the city of Brooklyn a modest shop for building his patent steam pump. From that small beginning the industry has grown to the present vast establishment covering nearly the whole of two city blocks, and giving employment to over 1,700 men.

Years ago the demands for space in the works became so great that the foundry was transformed to a shop for heavy machinery and the erection of large engines. A new iron foundry was erected at Elizabethport, N. J., and all the iron castings for the works are made there. Two steam lighters are kept continually in service carrying castings from the foundry to the South Brooklyn works. Both establishments are close to the water, so that there is no expense for railway or truck transfer. The most important feature of the work at the foundry is the extensive use of molding machines, which were introduced several years ago, with most satisfactory results. Their advantage lies not only in cheapening the cost of the castings themselves, but even more in the improvement in the quality of the work. Machine molding produces so firm and smooth surface in the mold that the casting comes from the sand with much smoother surfaces and made more accurately to the proper size than a casting from a hand-tamped flask. Thus the expense of machine finish is saved on surfaces which would otherwise require it, and the amount of metal which must be dressed off on such places as cylinder interiors is greatly reduced.



A VIEW IN THE TESTING ROOM.

The accompanying illustrations show interesting views in the interior of the works in South Brooklyn. In the first we have a view of the heavy machine shop, which is served by a Yale & Towne electric traveling crane of 20 tons capacity. The machine tools here are of the latest modern design. One Seller's planer is in the foreground at the right, and another is near the farther end of the shop. The radial drills in the middle distance

are from Bement, Miles & Co. and the Pond Machine Tool Works. In the large lathe on the left the low-pressure steam cylinder of a 15,000,000-gallon pumping engine for the water-works at Cleveland, O., is being bored and faced. Part of the water end of the same engine, a casting weighing some 27,000 lbs., is being lifted by the crane. The overhead steam pipes by which

THE DRYING-OUT ROOM.

the shop is heated are noticeable against the girders of the crane track. All the shops are heated in this manner, exhaust steam from the engines being used.

In the second view we have the heavy erecting shop adjoining the shop just described. This was formerly the iron foundry, and the heavy jib cranes seen there date back to the days when the foundry was in blast. The three cranes farthest from the point of view have recently been improved by the application of electric motors, greatly increasing their speed and efficiency. The first of these can swing a load of 15 tons, while the two in the background can handle 25 tons.

The large machine on the left about which several men are at work is a 20,000,000-gallon high duty pumping engine for the Spring Garden pumping station of Philadelphia's water-works, where it will soon be installed to hoist the muddy Schuylkill water into the Belmont reservoirs, 275 ft. above the river. Further particulars of this powerful machine will soon be given in Engineering News.

In front of the Philadelphia engine, to the left, a triple-expansion engine which is to go to Spain is being erected. Its steam cylinders are 13½ ins., 21 ins., and 33⅜ ins. in diameter respectively. In the right foreground, with the open ends of the steam cylinders gaping toward us, is a compound high pressure pump for the Penn Iron Mining Co. Two pumps of the same pattern have just been completed for the Cambria Iron Works.

View No. 3 shows the testing room, where all pumps, not too large to be readily portable, are brought after completion. The floor of the entire room is of concrete molded in channels, to permit the rapid draining off of water. The pumps to be tested are placed on low trucks and these are run onto a small transfer table, which runs in a shallow pit across the center of the room. Tracks extend at right angles to the pit on each side, and the truck with the pump mounted upon it may be run from the transfer table upon any track. The photograph shows a truck just being moved from the table to a testing track.

The pumps under test have the steam and exhaust, and the water supply and discharge connections made, and are run for a short time to determine that they will work satisfactorily under the required head and speed, and the valves and pistons are examined for tightness. The Moran flexible ball and socket joint, described in our issue of Aug. 29, 1891, has been used on the steam pipes for the past nine months and gives excellent satisfaction.

From the testing room the pumps are transferred to the room adjoining, shown in the fourth view, where cylinder heads and steam chest covers are taken off and the interior is thoroughly dried. The exterior is painted and bright parts are coated to protect them from corrosion. The pump is then ready to go to the storage room or to the packing room for shipment.

Some idea of the variety in sizes of the smaller pumps which the works turn out may be gained by examination of the views in the testing and drying-out rooms. The amount of machine work required on the great quantity of small pumps of moderate size which the works turn out is enormous, and shop after shop is devoted to various specialties. Among other labor-saving devices in use in the shops are small hydraulic cranes worked by a single movement of a lever. As some of these are located where the side strain on the building produced by a jib crane would be objectionable, the lifting trolley runs on a radial beam whose outer end is carried by a wheel running on a circular track suspended from the beams overhead.

Our final view is from a photograph taken in the drafting room. An idea of the extent of the works' output in pumping engines of the larger class may be gained from the fact that 15 draftsmen are kept busy. Complete records are, of course, kept of every pump sent out, so that the duplication of a pump or of any part thereof at any time is attended with no difficulty or uncertainty. On the roof above the drafting room is the blue-printing department, where two tons of paper every month are coated and printed. The printing frames are mounted on small trolleys running on tracks which

THE DRAFTING ROOM.

extend far enough out from the side of the building to place the glass in unobstructed light. When run back into the room the frame, which is hung on trunnions, is easily revolved, and the print and tracing are removed without lifting the glass.

The total capitalization of the company which owns the business established by Mr. Worthington is $7,000,000. Mr. W. A. Perry who was for many years associated with Henry R. Worthington, is President; and Mr. C. C. Worthington, son of the founder of the firm, is Chairman of the Executive Committee.